SECTION 4 PROPELLER SHAFT BRACKETS

1 Propeller shaft brackets

1.1 General

1.1.1 Propeller shafting is either enclosed in bossing or independent of the main hull and supported by shaft brackets.

1.1.2 Scantling methods

Two different methods are used to check the shaft brackets according to the type of yacht:

- The calculation of the working rate in the shaft brackets takes into account an "unbalance" caused by the absence of one propeller blade. This unbalance causes a centrifugal force which is assimilated to the centrifugal force of the missing blade F_C
- A second method may be used instead of the calculation here before if the moments in each arm of the shaft bracket M_1, M_2 or M, as defined in [3.2.2] and [3.3.3] are more than 20 kN.m

  This alternative calculation takes into account a moment caused by friction between the shaft propeller and the shaft brackets, caused by unexpected seizing.

2 Loss of a blade

2.1 General

2.1.1 This way of calculation concerns great yachts which are more often equipped of double arm propeller shaft brackets. The case with single arm propeller shaft brackets is developed for information.

2.2 Double arm propeller shaft brackets

2.2.1 General

This type of propeller shaft bracket consists in two arms arranged, as far as practicable, at right angles and converging in the propeller shaft bossing.

Exceptions to this will be considered by the Society on a case by case basis.

2.2.2 Scantlings of arms

The moment in the arm, in kN.m, is to be obtained from the following formula:

$$M = \frac{F_C}{\sin\alpha}\left(\frac{L}{\ell}d_1\cos\beta + L - \ell\right)$$

where:

F_C : Force, in kN, taken equal to:

$$F_C = \left(\frac{2\pi N}{60}\right)^2 R_P P$$

P : Mass of a propeller blade, in t

If this value is unknown, it is to be equal to:

$P = P_{PROP} / (n+1)$

P_{PROP} : Total mass of the propeller (hub included), in t

n : Number of propeller blades

N : Number of revolution per minute of the propeller

R_P : Distance, in m, of the centre of gravity of a blade in relation to the rotation axis of the propeller

If this value is unknown, it is to be equal to:

$R_P = D / 3$

D : Diameter of the propeller, in m

α : Angle between the two arms

β : Angle defined in Fig 1

d_1 : Distance, in m, defined in Fig 1

L, ℓ : Lengths, in m, defined in Fig 2.

Figure 1 : Angle β and length d_1

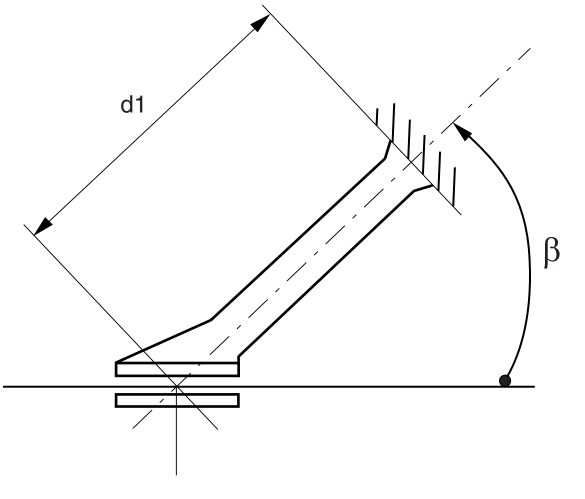
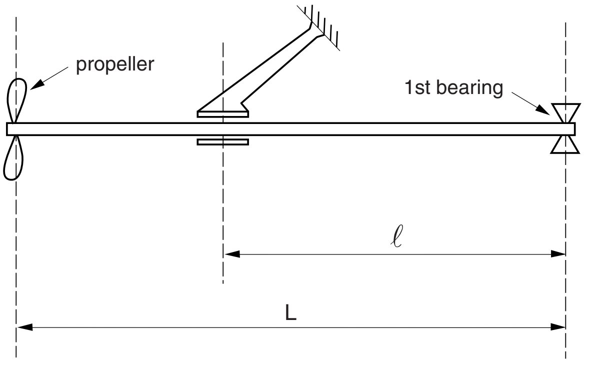


Figure 2 : Lengths L and ℓ



It is to be checked that the bending stress σ_F, the compression stress σ_N and the shear stress τ are in compliance with the following formula:

$$\sqrt{(\sigma_F + \sigma_N)^2 + 3\tau^2} \le \sigma_{ALL}$$

where:

$$\sigma_F = \frac{M}{w_A} 10^3$$

$$\sigma_N = 10 F_C \frac{L \sin\beta}{A \ell \sin\alpha}$$

$$\tau = 10 F_C \frac{L \cos\beta}{A_S \ell \sin\alpha}$$

σ_{ALL} : Allowable stress, in N/mm², equal to:

$$\sigma_{ALL} = \frac{70}{\chi}$$

where

χ : Material factor, as given below:

$\chi = 1$ for steel

$\chi = 2.3$ for aluminium

L : Rule length, in m, as defined in Ch 1, Sec 2, [3.2]

w_A : Section modulus, in cm³, of the arm at the level of the connection to the hull with respect to a transversal axis

A : Sectional area, in cm², of the arm

A_S : Shear sectional area, in cm², of the arm.

2.2.3 Allowable stress

A higher admissible stress may be considered by the Society in case by case, according to the type of yacht, its motorization (two independent shaft lines, sailing yacht...).

2.2.4 Scantlings of propeller shaft bossing

The length of the propeller shaft bossing is to be not less than the length of the aft sterntube bearing bushes (see Pt C, Ch 1, Sec 2, [4.3.5]).

The thickness of the propeller shaft bossing is to be not less than 0,33 d_P, where d_P is the propeller shaft diameter, in mm, measured inside the liner, if any.

2.2.5 Bracket arm attachments

In way of bracket arms attachments, the thickness of deep floors or girders is to be suitably increased. Moreover, the shell plating is to be increased in thickness and suitably stiffened.

The securing of the arms to the hull structure is to prevent any displacement of the brackets with respect to the hull.

2.3 Single arm propeller shaft brackets

2.3.1 General

This type of propeller shaft bracket consists of one arm generally used only in very small ships.

2.3.2 Scantling of arm

The moment in case of a single arm, in kN.m, is to be obtained from the following formula:

$$M = F_C \frac{L}{\ell} d_2$$

F_C : Force, in kN, as defined in [2.2.2]

d_2 : Length of the arm, in m, measured between the propeller shaft axis and the hull

L, ℓ : Lengths, in m, defined in Fig 2.

It is to be checked that the bending stress σ_F, the compression stress σ_N and the shear stress τ are in compliance with the following formula:

$$\sqrt{\sigma_F^2 + 3\tau^2} \le \sigma_{ALL}$$

where:

$$\sigma_F = \frac{M}{w_B} 10^3$$

$$\tau = 10 F_C \frac{L}{A_S \ell}$$

where:

A, A_S, σ_{ALL}: as defined in [2.2.2]

w_B : Section modulus, in cm³, of the arm at the level of the connection to the hull with respect to a longitudinal axis.

2.3.3 Scantlings of propeller shaft bossing

The length of the propeller shaft bossing is to be not less than the length of the aft sterntube bearing bushes (see Pt C, Ch 1, Sec 2, [4.3.5]).

The thickness of the propeller shaft bossing is to be not less than 0,33 d_P (d_P defined in [2.2.4]).

2.3.4 Bracket arm attachments

In way of bracket arms attachments, the thickness of deep floors or girders is to be suitably increased. Moreover, the shell plating is to be increased in thickness and suitably stiffened.

The securing of the arms to the hull structure is to prevent any displacement of the brackets with respect to the hull.

2.4 Bossed propeller shaft brackets

2.4.1 General

Where bossed propeller shaft brackets are fitted, their scantlings are to be considered by the Society on a case by case.

2.4.2 Scantling of the boss

The length of the boss is to be not less than the length of the aft sterntube bearing bushes (See Pt C, Ch 1, Sec 2, [4.3.5]).

The thickness of the boss, in mm, is to be not less than 0,33 d_P (d_P defined in [2.2.4]).

The aft end of the bossing is to be adequately supported.

2.4.3 Scantling of the end supports

The scantlings of end supports are to be specially considered. Supports are to be adequately designed to transmit the loads to the main structure.

End supports are to be connected to at least two deep floors of increased thickness or connected to each other within the ship.

2.4.4 Stiffening of the boss plating

Stiffening of the boss plating is to be specially considered. At the aft end, transverse diaphragms are to be fitted at every frame and connected to floors of increased scantlings.

At the fore end, web frames spaced not more than four frames apart are to be fitted.

3 Alternative calculation seizing

3.1 General

3.1.1 Application

As indicated in [1.1.2], this alternative method is applicable if the moments in each arm of the shaft bracket M_1, M_2 or M as defined in [3.2.2] and [3.3.2] are greater than 20 KNm.

3.1.2 The seizing phenomenon is caused by friction between the propeller shaft and the propeller shaft bossing, supported by the shaft brackets.

It is considered that the propeller torque M_P is transmitted in full to the shaft bracket. The propeller torque M_P, in kN.m, is to be obtained from the following formula:

$$M_P = \frac{P_P}{\frac{2\pi N}{60}}$$

where:

- N : Number of revolution per minute of the propeller
- P_P : Power transmitted to the propeller, in kW

3.1.3 The angle β defined in Fig 1 is neglected if it is not less than 80°. If this condition is not respected, direct calculation will have to be made on a case by case.

3.2 Double arm propeller shaft brackets

3.2.1 General

This type of propeller shaft bracket consists in two arms arranged, as far as practicable, at right angles and converging in the propeller shaft bossing.

Exceptions to this will be considered by the Society on a case by case basis.

3.2.2 Scantlings of arms

The moment in each arm, in kN.m, at the attachment with the shaft propeller is to be obtained from the following formulae:

$$M_1 = \frac{M_P}{1 + \frac{E_2 I_2 d_1}{E_1 I_1 d_2}}$$

$$M_2 = \frac{M_P}{1 + \frac{E_1 I_1 d_2}{E_2 I_2 d_1}}$$

where:

- M_P : Propeller torque, in kN.m,as estimated in [3.1.2]
- E_1, E_2 : Young's modulus of each arm, in N/mm²
- I_1, I_2 : Inertia of each arm, in cm⁴
- d_1, d_2 : Length of each arm, in m, measured between the propeller shaft axis and the hull

Note 1: $M_1 + M_2 = M_P$

In each arm, it is to be checked that the bending stresses σ_{F1} and σ_{F2}, the compressive stresses σ_{N1} and σ_{N2} and the shear stresses τ_1 and τ_2 are in compliance with the following formulae:

$$\sqrt{(\sigma_{F1} + \sigma_{N1})^2 + 3\tau_1^2} \le \sigma_{ALL,S}$$

$$\sqrt{(\sigma_{F2} + \sigma_{N2})^2 + 3\tau_2^2} \le \sigma_{ALL,S}$$

where:

$$\sigma_{F1} = \frac{M_1}{w_{B,1}} 10^3$$

$$\sigma_{F2} = \frac{M_2}{w_{B,2}} 10^3$$

$$\sigma_{N1} = 10,\frac{3}{2A_1 \sin\alpha}\left(\frac{M_2}{d_2} + \frac{M_1}{d_1}\cos\alpha\right)$$

$$\sigma_{N2} = 10,\frac{3}{2A_2 \sin\alpha}\left(\frac{M_1}{d_1} + \frac{M_2}{d_2}\cos\alpha\right)$$

$$\tau_1 = 10\frac{3M_1}{2d_1 A_{S,1}}$$

$$\tau_2 = 10\frac{3M_2}{2d_2 A_{S,2}}$$

where:

- $\sigma_{ALL,S}$: Allowable stress, in N/mm², equal to:

  $$\sigma_{ALL,S} = 0,8 \cdot \frac{235}{k}$$

  where

  - k : Material factor, as defined in Ch 4, Sec 3, [3.1]
- $w_{B,1}$, $w_{B,2}$: Section modulus, in cm³, of each arm at the level of the connection to the hull with respect to a longitudinal axis
- A_1, A_2 : Sectional area, in cm², of each arm
- $A_{S,1}$, $A_{S,2}$: Shear sectional area, in cm², of each arm.

3.2.3 Scantlings of propeller shaft bossing

The length of the propeller shaft bossing is to be not less than the length of the aft sterntube bearing bushes (see Pt C, Ch 1, Sec 2, [4.3.5]).

The thickness of the propeller shaft bossing is to be not less than 0,33 d_P -(d_P defined in [2.2.4]).

3.2.4 Bracket arm attachments

In way of bracket arms attachments, the thickness of deep floors or girders is to be suitably increased. Moreover, the shell plating is to be increased in thickness and suitably stiffened.

The securing of the arms to the hull structure is to prevent any displacement of the brackets with respect to the hull.

3.3 Single arm propeller shaft brackets

3.3.1 General

This type of propeller shaft bracket consists of one arm used only in very small ships.

3.3.2 Scantling of arm

The moment in case of a single arm, in kN.m, is to be obtained from the following formula:

$$M = M_p$$

where:

M_P : As defined in [3.2.2]

It is to be checked that the bending stress σ_F is less than the admissible stress:

$$\sigma_F \leq \sigma_{ALL,S}$$

where:

$$\sigma_F = \frac{M}{w_B} 10^3$$

w_B : As defined in [2.3.2]

σ_{ALL} : As defined in [2.2.2].

3.3.3 Scantlings of propeller shaft bossing

The length of the propeller shaft bossing is to be not less than the length of the aft sterntube bearing bushes (see Pt C, Ch 1, Sec 2, [4.3.5]).

The thickness of the propeller shaft bossing is to be not less than 0,33 d_P (d_P defined in [2.2.4]).

3.3.4 Bracket arm attachments

In way of bracket arms attachments, the thickness of deep floors or girders is to be suitably increased. Moreover, the shell plating is to be increased in thickness and suitably stiffened.

The securing of the arms to the hull structure is to prevent any displacement of the brackets with respect to the hull.

3.4 Bossed propeller shaft brackets

3.4.1 General

Where bossed propeller shaft brackets are fitted, their scantlings are to be considered by the Society on a case by case.

3.4.2 Scantling of the boss

The length of the boss is to be not less than the length of the aft sterntube bearing bushes (See Pt C, Ch 1, Sec 2, [4.3.5]).

The thickness of the boss, in mm, is to be not less than 0,33 d_P (d_P defined in [2.2.4]).

The aft end of the bossing is to be adequately supported.

3.4.3 Scantling of the end supports

The scantlings of end supports are to be specially considered. Supports are to be adequately designed to transmit the loads to the main structure.

End supports are to be connected to at least two deep floors of increased thickness or connected to each other within the ship.

3.4.4 Stiffening of the boss plating

Stiffening of the boss plating is to be specially considered. At the aft end, transverse diaphragms are to be fitted at every frame and connected to floors of increased scantlings.

At the fore end, web frames spaced not more than four frames apart are to be fitted.