SECTION 2 HULL GIRDER AND PLATFORM OF CATAMARANS

1 Hull girder

1.1 General

1.1.1 The global loads are to be taken into account for the review of hull girder of monohull and catamaran and for the cross deck of catamaran in the cases listed in Ch 6, Sec 1, [1.3].

1.1.2 The design review of hull girder structure consists in:

- checking that global stresses safety factors SF are more than the admissible values given in Ch 4, Sec 3, [5.4]
- checking that the actual safety factors for buckling of plating contributing to longitudinal hull girder strength are more than the admissible values given in Ch 4, Sec 3, [5.4].

1.1.3 The calculation of global stresses is carried out on basis of:

- the combination of global loads (bending moments) as indicated in Ch 6, Sec 4
- the actual strength characteristics of the hull girder as indicated in Ch 4, Sec 4.

1.1.4 The buckling strength of structural members contributing to the longitudinal hull girder strength is checked on basis of the relevant requirements of Ch 9, Sec 3 for plating.

1.1.5 As a rule, the checking of the hull girder strength is to be carried out for monohull yachts and for catamaran yachts.

2 Cross deck of catamaran

2.1 Estimation of stiffness of cross deck

2.1.1 The design review of the main structure of the cross deck of catamarans under global wave torque may be checked by means of a beam model analysis, as shown on Fig 1. Any other justified checking method may be considered.

This design review consists in:

- checking that global stresses safety factors SF in floats are more than the admissible values given in Ch 4, Sec 3, [5.4]
- checking that local stresses safety factors SF in cross connecting structure (cross beams or transverse bulkheads) are more than the admissible values given in Ch 4, Sec 3, [5.4].

2.1.2 The purpose of the present calculation is to determine the loads distribution in the cross deck between floats, versus flexural and shear stiffnesses of the primary structure of the cross deck.

2.1.3 Each resisting transverse member between floats is modelized as a beam, taking account of:

- flexural inertia about an horizontal axis, depending mainly on the web height of the transverse cross beam or bulkhead, the roof deck thickness or the float deck thickness, the thickness of the underside of the cross deck (wet deck) and the young modulus of each of these elements
- vertical shear inertia, depending on the web height of the transverse cross beams or bulkheads, their thicknesses and their own shear modulus
- their span between inner side shell of floats.

2.1.4 As far as possible, the beam model of the float is to have:

- vertical and horizontal inertias and young modulus close to the actual one of the float
- a shear inertia and shear modulus close to the actual one of the float
- a torsional inertia about longitudinal float axis and shear modulus close to the actual one of the float.

The second float is not described as a beam in the beam model. Instead, the transverse cross beams in the beam model are fully fixed at their intersection with this float.

2.1.5 The flexural inertia, young modulus, shear inertia and shear modulus of each structural element of the model can be estimated as defined in Ch 12, Sec 4.

2.1.6 Wave torque model

The wave torque moment exerted on the cross deck may be represented by 2 vertical forces F, equal in magnitude and opposite in direction, as shown on Fig 2. The magnitude of the force F, in kN, is to be taken equal to:

$F = M_{WT} / L_{WL}$

where:

M_{WT} : Wave torque moment, in kN.m, calculated according to Ch 6, Sec 2, [2.3]

L_{WL} : Length of the float at full load waterline, in m, as described in the beam model (see Fig 1).

2.1.7 Digging in loading model

The loading due to digging in, as described in Ch 6, Sec 3, [3], may be satisfactorily taken into account in the beam model by applying a differential vertical loading F_V (difference between the vertical loads exerted on both floats) and a differential horizontal load F_H (difference between the horizontal loads exerted on both floats), as shown on Fig 3.

The linear loads to input in the beam model, F_V and F_H , in kN/m, are to be calculated as follows, with F′ and F″ calculated according to Ch 6, Sec 3, [3.2]:

$$F_V = \frac{F'/3}{L_{WL}/4}$$

$$F_H = \frac{F''/3}{L_{WL}/4}$$

Figure 1 : Cross deck of catamarans - Model principle

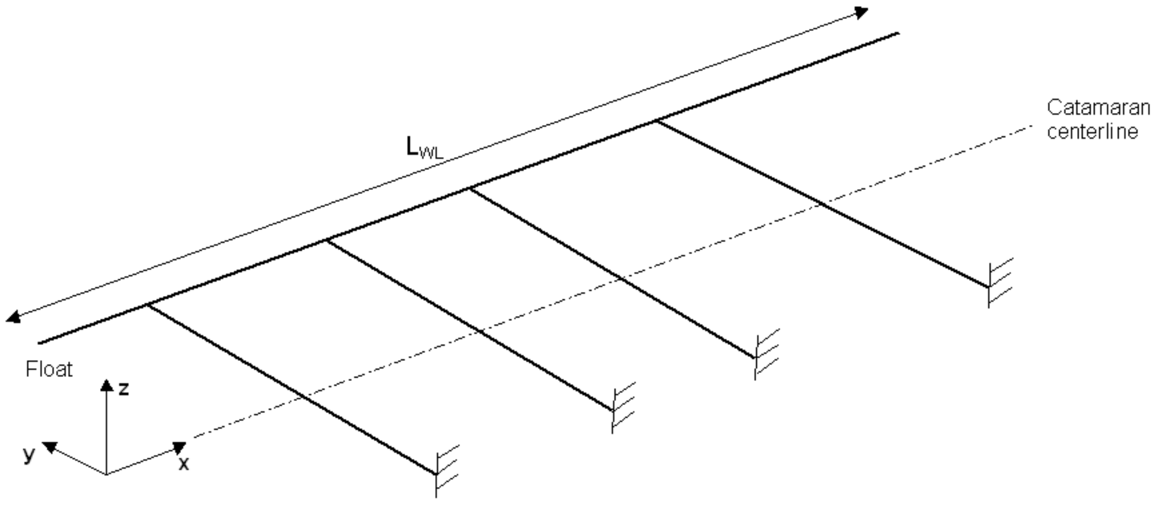
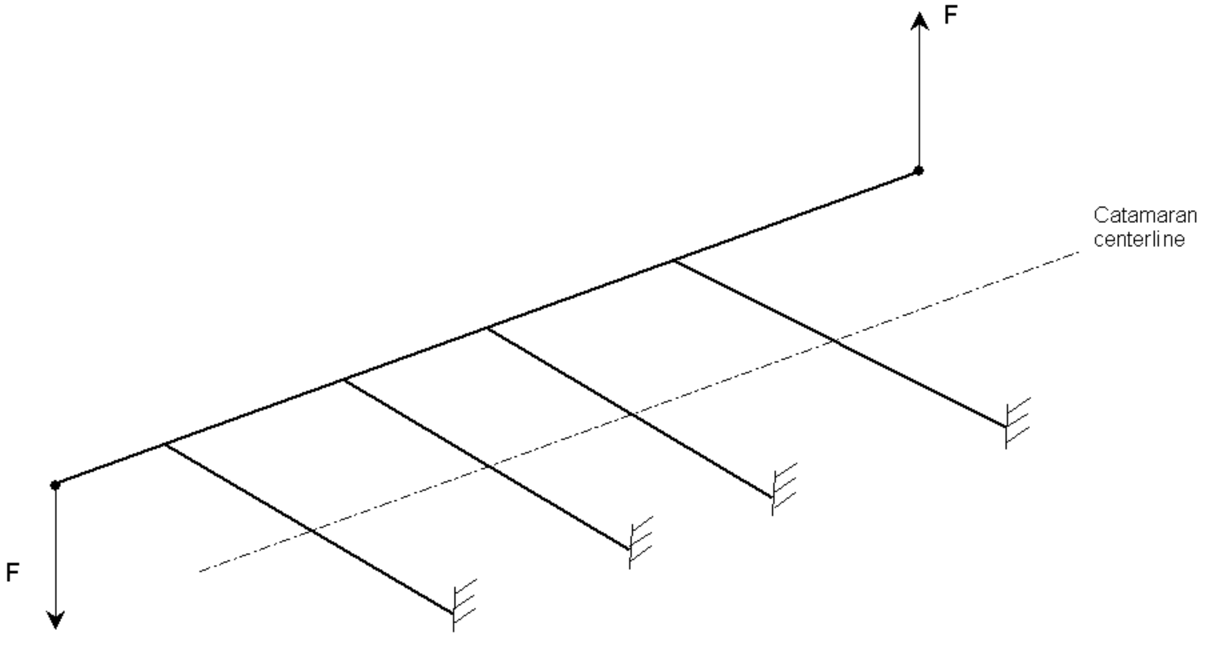


Figure 2 : Application of wave torque in beam model



2.1.8 Rig torque

For catamaran sailing yacht, the torque exerted by standing rigging may be represented by 2 vertical forces F_{RIG}, equal in magnitude and opposite in direction, as indicated in [2.1.6]. The magnitude of the force F, in kN, is to be taken equal to:

$F_{RIG} = M_{RIGT} / L_{WL}$

where:

M_{RIGT} : Rig torque, in kN.m, calculated according to the method given in Ch 6, Sec 3, [2.4]

L_{V1}', L_{D1}', L_P': Distances, in m, between various chain plates of the standing rigging and the center of rotation of the cross deck, measured according to Fig 4.

The longitudinal position of the center of rotation of the cross deck is estimated from the results of the beam model analysis specified in [2.1.6].

2.1.9 Combination of loadings

The two loading cases are defined in Ch 6, Sec 4 and are reminded below for information:

- wave torque loading combined with 70 percent of the rig torque
- digging in torque combined with 70 percent of the rig torque.

Figure 3 : Application of digging in loads in beam model

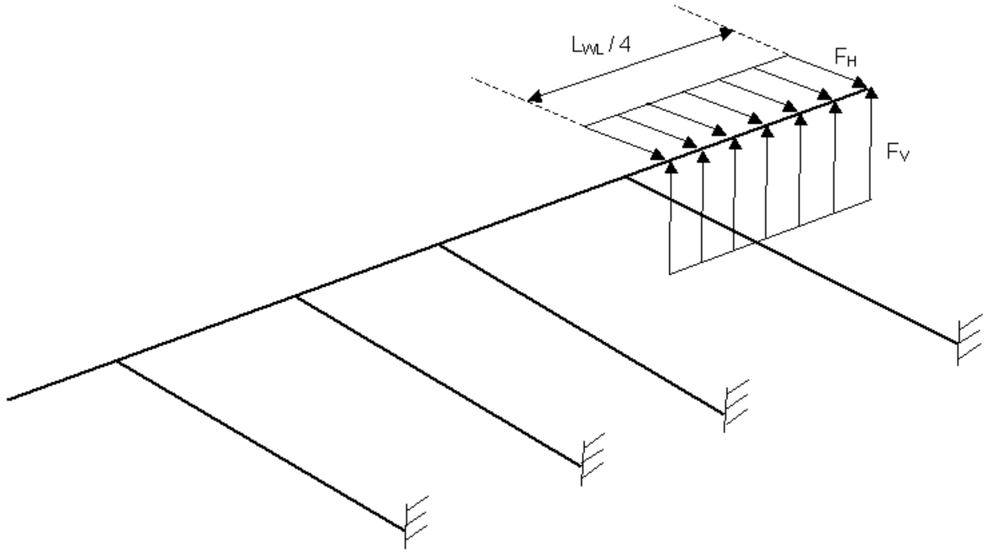
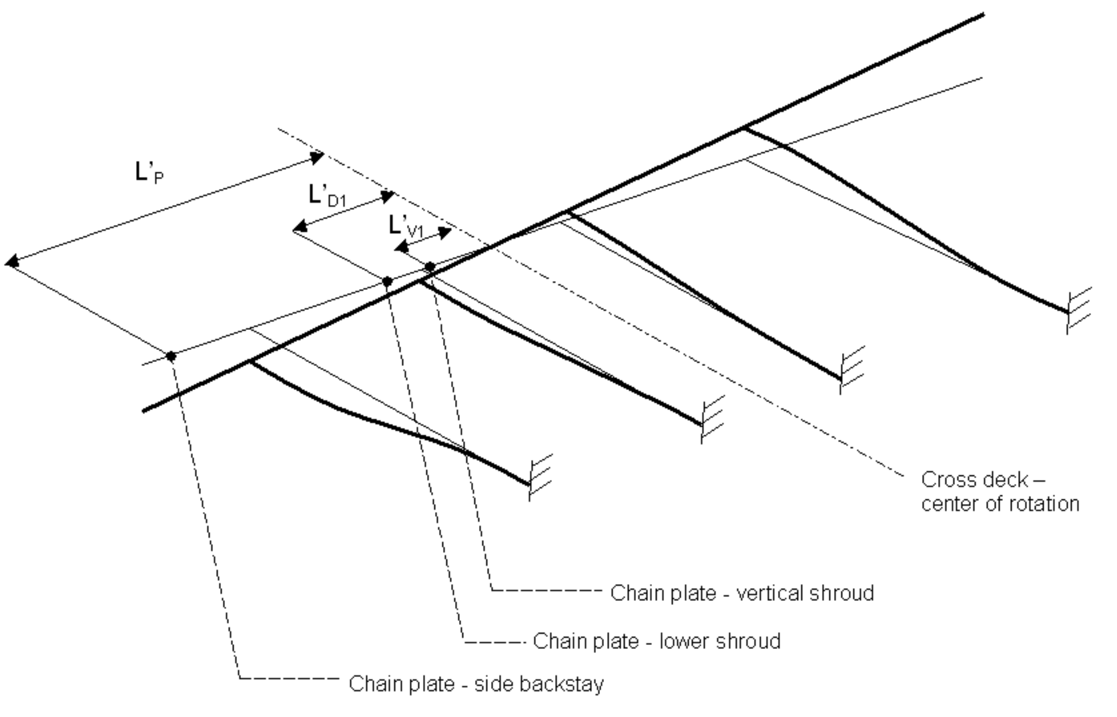


Figure 4 : Rig lever arm inducing rig torque



2.2 Floats structure

2.2.1 The structure of each float is to be checked as indicated in [1], considering the vertical bending moments and the vertical shear forces coming from the beam model analysis performed to check the cross deck structure, as shown on Fig 5.

2.2.2 The geometrical characteristics of the float may be determined using Bureau Veritas Rule software or any other equivalent mean (see Ch 1, Sec 4).

The transverse sections to be considered are to take into account all the longitudinal continuous members (laminates and longitudinal stiffeners) in the area shown on Fig 6, where:

b_R : Breadth equal to 10% of the roof length

b_{WD} : Breadth equal to 10% of the cross deck length.

Figure 5 : Overall loads in the float

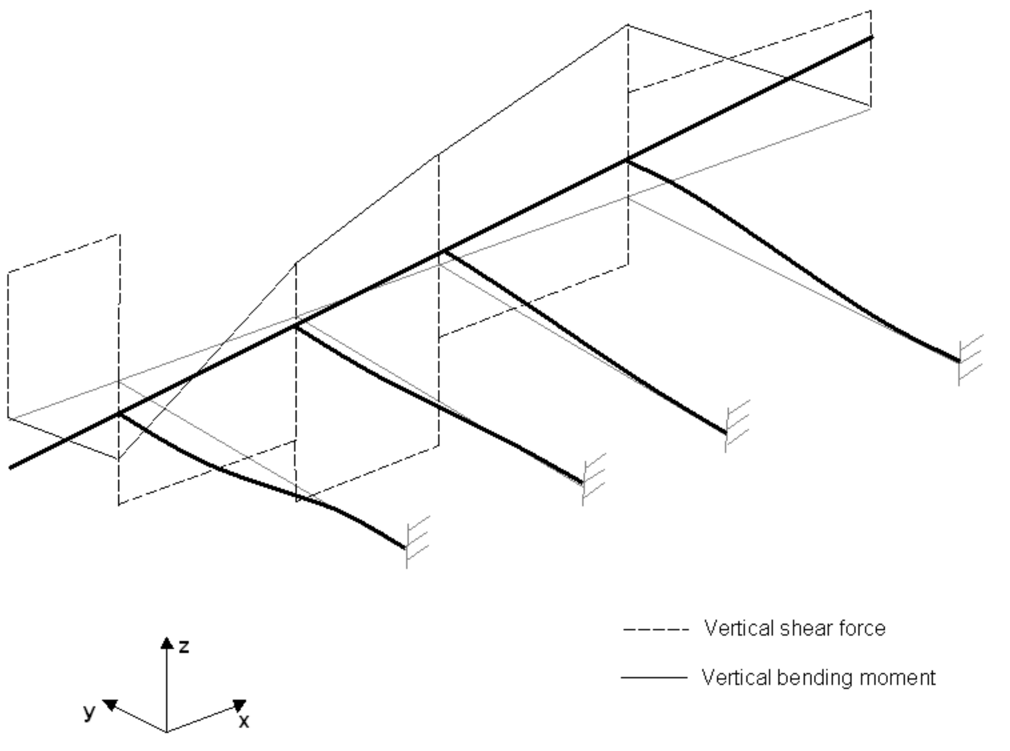


Figure 6 : Area to take into account for continuous members (laminates and stiffeners) for hull girder strength

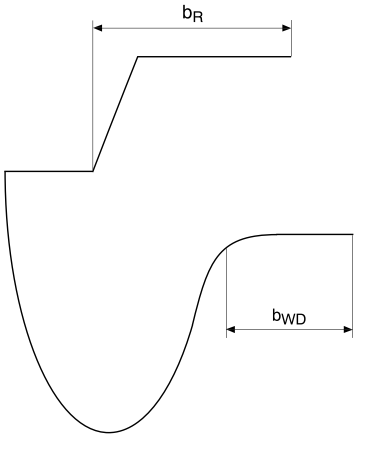
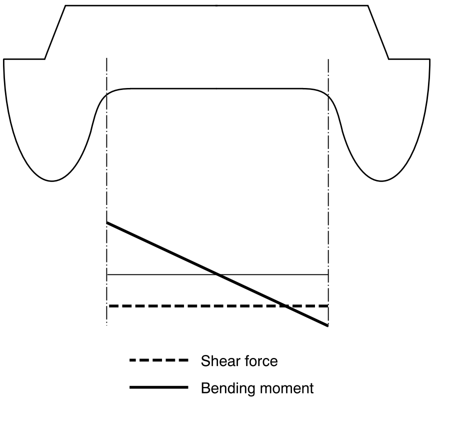


Figure 7 : Transverse distribution of bending moment and shear force



2.3 Primary transverse structure between floats

2.3.1 Each resisting transverse cross member between floats (cross beams, bulkheads) is checked against flexural and shear strength, taking account of the bending moments and shear forces resulting from the beam model analysis described in [2.1].

The values of bending moments and shear forces to consider are the one calculated in the transverse beams of the beam model, in way of the modelized float.

The transverse distribution of vertical bending moments and vertical shear force is indicated in Fig 7.

2.3.2 Particular attention is to be paid to:

- shear buckling check of transverse bulkheads
- compression/bending buckling check of wet deck and cross deck plating in areas where the bending moment is maximum.

2.3.3 For catamarans sailing yachts, the cross beam supporting the mast is to be checked as indicated in [2.3.1] and [2.3.2], with added effect of loads induced by mast on this particular cross beam.

This cross beam may be considered as fixed in way of inside side plating of floats and loaded by the mast (considered as a concentrated force).

The mast compressive load, as given by the Shipyard or the Designer, is to be considered with a contribution factor 0,7.