SECTION 10 PILLARS IN COMPOSITE MATERIAL

1 General

1.1 Application

1.1.1 The requirements of this Section apply to pillars (independent profiles or bulkheads stiffeners) made of composites.

1.1.2 The present Section deals with the buckling check of the pillars.

The general requirements relating to pillars arrangement is given in Ch 9, Sec 7, [3].

2 Buckling of pillars subjected to compression axial load

2.1 Compression axial load

2.1.1 Where pillars are aligned, the compression axial load F_A, in kN, is equal to the sum of loads supported by the pillar considered and those supported by the pillars located above, multiplied by a weighting factor.

The weighting factor depends on the relative position of each pillar with respect to that considered.

The compression axial load in the pillar is to be obtained, in kN, from the following formula:

$$F_A = A_D p_s + \sum_i r Q_i$$

where:

A_D : Area, in m², of the portion of the deck or the platform supported by the pillar considered

p_s : Pressure on deck, in kN/m², as defined in Ch 7, Sec 1, [3]

r : Coefficient which depends on the relative position of each pillar above the one considered, to be taken equal to:

- $r = 0,9$ for the pillar immediately above that considered
- $r = 0,9^i$ for the i^{th} pillar of the line above the pillar considered, to be taken not less than 0,478

Q_i : Vertical load, in kN, from the i^{th} pillar of the line above the pillar considered, if any.

2.2 Hollow tubular pillars

2.2.1 Critical column buckling load of hollow tubular pillars

The critical column buckling load of hollow tubular pillars is to be obtained, in kN, from the following formula:

$$F_{CR1} = \frac{\pi^2 I E}{(f\ell)^2} 10^{-5}$$

where:

I : Minimum moment of inertia, in cm⁴, of the pillar

$$I = \frac{\pi(d^4_{EXT} - d^4_{INT})}{64}$$

d_{EXT}, d_{INT} : External and internal diameter, in cm, of the pillar

ℓ : Span, in m, of the pillar

f : Coefficient, to be obtained from Tab 1

E : Young's modulus, in N/mm², of the global laminate in the longitudinal direction of the pillar, as defined in Ch 12, Sec 4, [5.1.2].

2.2.2 Global checking criteria

The composite pillars loaded by the compression axial load F_A defined in [2.1.1] are first to respect the following condition:

$$F_A \le F_{CR}/SF_G$$

where:

SF_G : Safety factor, equal to: $SF_G = 3\ C_F$

with C_F as defined in Ch 4, Sec 3, [5.4.1]

F_{CR1} : Critical column buckling load, in kN, as defined in [2.2.1]

2.2.3 Local checking criteria

Each individual layer of the laminate is to resist locally to load compression and to respect the following condition:

$$\varepsilon_A \le \varepsilon_{BR,k}/SF$$

where

SF : Safety factor of the individual layer as defined in Ch 4, Sec 3, [5.4.1]

$\varepsilon_{BR,k}$: Theoretical breaking strain, in compression in the longitudinal axis of the pillar, of the individual layer k, as defined in Ch 12, Sec 3, Tab 5

ε_A : Global strain, in percent, in compression in the longitudinal axis of the pillar, of the laminate, equal to:

$$\varepsilon_A = \frac{4F_A}{E\pi(d^2_{EXT} - d^2_{INT})} 10^3$$

d_{EXT}, d_{INT} : Extrenal and internal diamater, in cm, of the pillar

E : Young's modulus, in N/mm², of the global laminate in the longitudinal direction of the pillar, as defined in Ch 12, Sec 4, [5.1.2].

F_A : As defined in [2.1.1]

2.3 Hollow rectangular pillars

2.3.1 Critical column buckling load of hollow rectangular pillars

The critical column buckling load of hollow rectangular pillars is to be obtained, in kN, from the following formula:

$$F_{CR2} = \frac{\pi^2 I E}{(f\ell)^2} 10^{-5}$$

where:

I : Minimum moment of inertia, in cm⁴, of the pillar

$$I = \left(\frac{bh^3}{12} - \frac{(b-2t)(h-2t)^3}{12}\right) 10^{-4}$$

b : Length, in mm, of the shorter side of the section

h : Length, in mm, of the longer side of the section

t : Laminate thickness, in mm, of all the side of the section

ℓ : Span, in m, of the pillar

f : Coefficient, to be obtained from Tab 1

E : Young's modulus, in N/mm², of the global laminate in the longitudinal direction of the pillar, as defined in Ch 12, Sec 4, [5.1.2].

2.3.2 Global checking criteria

The composite pillars loaded by the compression axial load F_A defined in [2.1.1] are first to respect the following condition:

$F_A \leq F_{CR2} / SF_G$

where:

SF_G : Safety factor, equal to: $SF_G = 3\ C_F$

with C_F as defined in Ch 4, Sec 3, [5.4.1]

F_{CR2} : Critical column buckling load, in kN, as defined in [2.2.1]

2.3.3 Local checking criteria

Each individual layer of the laminate is to resist locally to load compression and to respect the following condition:

$\varepsilon_A \leq \varepsilon_{BR,k} / SF$

where

SF : Safety factor of the individual layer as defined in Ch 4, Sec 3, [5.4.1]

$\varepsilon_{BR,k}$: Theoretical breaking strain, in compression in the longitudinal axis of the pillar, of the individual layer k, as defined in Ch 12, Sec 3, Tab 5

ε_A : Global strain, in percent, in compression in the longitudinal axis of the pillar, of the laminate, equal to:

$$\varepsilon_A = \frac{F_A}{2Et(h+b-2t)} 10^5$$

b : Length, in mm, of the shorter side of the section

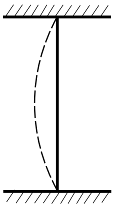
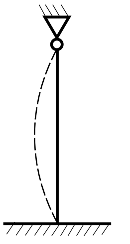
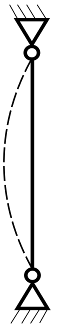
h : Length, in mm, of the longer side of the section

t : Laminate thickness, in mm, of all the side of the section

E : Young's modulus, in N/mm², of the global laminate in the longitudinal direction of the pillar, as defined in Ch 12, Sec 4, [5.1.2].

F_A : As defined in [2.1.1].

Table 1 : Coefficient f

Boundary conditions of the pillar	f
Both ends fixed 	0,5
One end fixed, one end pinned 	$\frac{\sqrt{2}}{2}$
Both ends pinned 	1,0