NATIONAL ANNEX TO CYS EN 1993-3-1:2006 (Including AC:2009)

Eurocode 3: Design of steel structures

Part 3-1: Towers, masts and chimneys – Towers and masts

CYPRUS ORGANISATION FOR STANDARDISATION

NATIONAL ANNEX

TO

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CYS EN 1993-3-1:2006 +AC:2009

Eurocode 3: Design of steel structures

Part 3-1: Towers, masts and chimneys – Towers and masts

This National Annex has been approved by the Board of Directors of the Cyprus Organisation for Standardisation (CYS) on 14.06.2019.

INTRODUCTION

This National Annex has been prepared by the CYS TC 18 National Standardisation Technical Committee of the Cyprus Organisation for Standardisation. (CYS)

NA 1 SCOPE

This National Annex is to be used together with CYS EN 1993-3-1:2006+AC: 2009.Any reference in the rest of this text to CYS EN 1993-3-1:2006 means the above document.

This National Annex gives:

(a) Nationally determined parameters for the following clauses of CYS EN 1993-3-1:2006 where National choice is allowed (see Section NA 2)

- 2.1.1(3)P
- 2.3.1(1)
- 2.3.2(1)
- 2.3.6(2)
- 2.3.7(1)
- 2.3.7(4)
- 2.5(1)
- 2.6(1)
- 4.1(1)
- 4.2(1)
- 5.1(6)
- 5.2.4(1)
- 6.1(1)
- 6.3.1(1)
- 6.4.1(1)
- 6.4.2(2)
- 6.5.1(1)
- 7.1(1)
- 9.5(1)
- A.1(1)
- A.2(1)P (2 places)
- B.1.1(1)
- B.2.1.1(5)
- B.2.3(1)
- B.3.2.2.6(4)
- B.3.3(1)
- B.3.3(2)
- B.4.3.2.2(2)
- B.4.3.2.3(1)
- B.4.3.2.8.1(4)
- C.2(1)
- C.6.(1)
- D.1.1(2)
- D.1.2(2)
- D.3(6) (2 places)

- D.4.1(1)
- D.4.2(3)
- D.4.3(1)
- D.4.4(1)
- F.4.2.1(1)
- F.4.2.2(2)
- G.1(3)
- H.2(5)
- H.2(7)

(b) Decisions on the use of the Informative Annexes B, C, E, F, G and H (see Section NA 3)

(c) References to non-contradictory complementary information to assist the user to apply CYS EN 1993-3-1:2006. In this National Annex such information is provided for the following clauses in CYS EN 1993-3-1:2006 (see Section NA 4)

- None

NA 2 NATIONALLY DETERMINED PARAMETERS

NA 2.1 Clause 2.1.1(3)P Basic requirements

Annex E shall be used.

NA 2.2 Clause 2.3.1(1) Wind actions

Annex B shall be used.

NA 2.3 Clause 2.3.2(1) Ice loads

Annex C shall be used.

NA 2.4 Clause 2.3.6(2) Imposed loads

The characteristic imposed loads on platforms and railings are specified as

- Imposed loads on platforms: **2,0 kN/m^2** 2.1a (CYS)
- Horizontal loads on railings: **0,5 kN/m** 2.1b (CYS)

NA 2.5 Clause 2.3.7(1) Other actions

No information is provided on the choice of accidental actions.

NA 2.6 Clause 2.3.7(4) Other actions

No further information is provided on actions arising from the fitting and anchoring of safety access equipment.

NA 2.7 Clause 2.5(1) Design assisted by testing

No further information is provided on structures or elements that are subject to an agreed full-scale testing programme.

NA 2.8 Clause 2.6(1) Durability

The design service life of the structure is specified as 30 years.

NA 2.9 Clause 4.1(1) Allowance for corrosion

No further information is provided on corrosion protection.

NA 2.10 Clause 4.2(1) Guys

The following measures should be adopted on the corrosion protection of guys:

Dependent on the environmental conditions guy ropes made from galvanized steel wires should be given a further layer of protection, such as grease or paint. Care should be taken to ensure that this protective layer is compatible with the lubricant used in the manufacture of the guy ropes.

As an alternate means of protection galvanised steel ropes of diameter up to 20 mm may be protected by polypropylene impregnation in which case they do not need further protection unless the sheath is damaged during erection and use. Care needs to be taken in designing the terminations to ensure adequate corrosion protection. Non-impregnated sheathed ropes should not be used because of the risk of corrosion taking place undetected.

Lightning may locally damage the polypropylene coating.

NA 2.11 Clause 5.1(6) Modelling for determining action effects

No further information is provided.

NA 2.12 Clause 5.2.4(1) Triangulated structures where continuity is taken into account (continuous or semi-continuous framing)

No further information is provided.

NA 2.13 Clause 6.1(1) General

The partial factors γ_M are specified as

$\gamma_{M0} = 1,00$

$\gamma_{M1} = 1,00$

$\gamma_{M2} = 1,25$

$\gamma_{Mg} = 2,00$

$\gamma_{Mi} = 2,50$

NA 2.14 Clause 6.3.1(1) Compression members

Compression members in lattice towers and masts should be designed using one of the following two procedures:

a) the method according to the provisions of Annex G and Annex H.
b) the method given in EN 1993-1-1, Annex B B.1.2(2)B taking account of eccentricities.

NA 2.15 Clause 6.4.1(1) General

The partial factors for connections in masts and towers are given in Table 2.1 (CYS) of the National Annex of CYS EN 1993-1-8, which is repeated below.

Table 2.1 (CYS): Partial safety factors for joints

Resistance of members and cross-sections	γ_{M0} , γ_{M1} and γ_{M2} see CYS EN 1993-1-1
Resistance of bolts	γ_{M2}
Resistance of rivets	
Resistance of pins	
Resistance of welds	
Resistance of plates in bearing	
Slip resistance - for hybrid connections or connections under fatigue loading - for other design situations	γ_{M3} γ_{M3}
Bearing resistance of an injection bolt	γ_{M4}
Resistance of joints in hollow section lattice girder	γ_{M5}
Resistance of pins at serviceability limit state	$\gamma_{M6,ser}$
Preload of high strength bolts	γ_{M7}
Resistance of concrete	γ_c see CYS EN 1992-1-1

Numerical values for γ_M are specified as

$\gamma_{M2} = 1{,}25$; $\gamma_{M3} = 1{,}25$ for hybrid connections or connections under fatigue loading and $\gamma_{M3} = 1{,}1$ for other design situations; $\gamma_{M4} = 1{,}0$; $\gamma_{M5} = 1{,}0$; $\gamma_{M6,ser} = 1{,}0$; $\gamma_{M7} = 1{,}1$.

NA 2.16 Clause 6.4.2(2) Tension bolts in end plates (flanged connections)

No further information is provided on flange connections of circular hollow sections and cylindrical shells.

For circular hollow sections the following simplified method for members in tension without bending, of 6.4.2(2) of CYS EN 1993-3-1 is recommended, see figure 6.1.
In determining the flange thickness the following is relevant:

a) the shear resistance of the flange along the perimeter of the connected circular leg section;

b) the resistance to combined bending and shear of the flange along the circle through the bolt holes. The bending moment (M) may be taken as:

$M = N (D_b - D_i)/2$

where: N is the tension force in the leg member

D_b is the diameter of the circle through the centre of the bolt holes

D_i is the diameter of the leg member

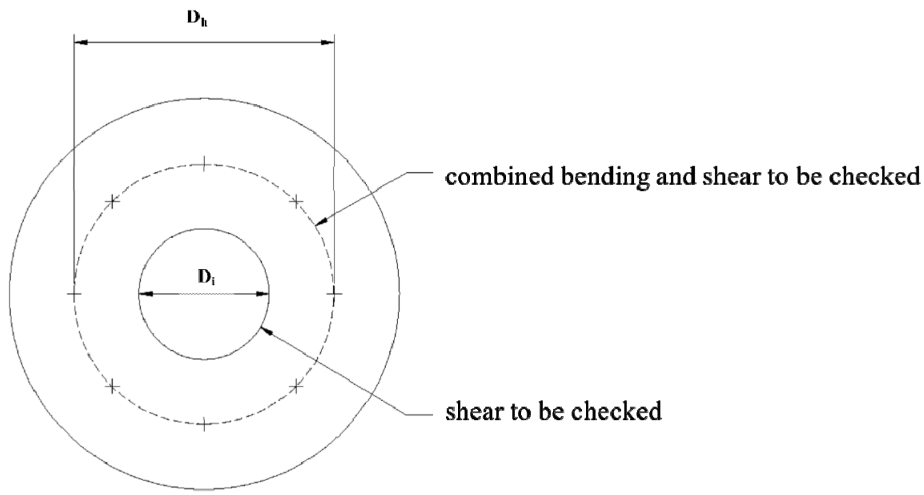


Figure 6.1 (CYS): Bolted flanged connections

In determining the forces in the bolts, the axial force N_b

$$N_b = \frac{Nk_p}{n}$$

where: n is the number of bolts

k_p is a prying effect factor taken as

k_p = 1,2 for pre-loaded bolts

= 1,8 for non-preloaded bolts

All bolts should be preloaded for fatigue, see CYS EN 1993-1-8

NA 2.17 Clause 6.5.1(1) Mast base joint

No information is provided on eccentricities and limit values for the Hertz pressure.

To verify that the area of the compression zone is within the boundaries of the bearing parts taking due account of the true rotation angle of the mast base section (see Figure 6.2) and to determine the bending moments caused by the resulting eccentricities for designing the bearing and the bottom section of the mast the following rules for determining eccentricities are recommended:

If the mast base rests on a spherical bearing the point of contact should be assumed to move in the direction of any inclination of the mast axis by rolling over the bearing surface.

The eccentricities e_u and e_o (see Figure 6.2) should be determined as follows:

$$e_u = r_1 \times \sin\psi_1 \quad \text{... (6.12a (CYS))}$$

$$e_o = r_2 (\sin \psi_1 - \sin \phi) \quad \text{... (6.12b (CYS))}$$

where: r_1 is the radius of the convex part of the bearing;

r_2 is the radius of the concave part of the bearing;

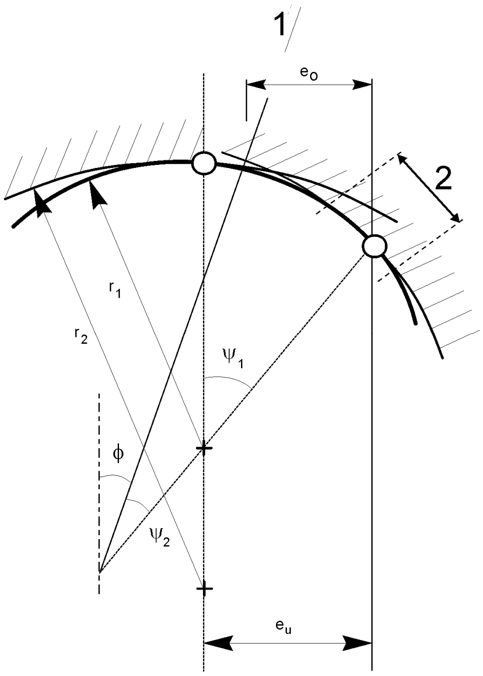
and $r_2 > r_1$

ϕ is the inclination of the mast axis at its base.

with: $\psi_1 = \frac{r_2 \phi}{r_2 - r_1}$ ... (6.13a (CYS))

$\psi_2 = \psi_1 - \phi$ ... (6.13b (CYS))

If r_2 is infinite, that is a flat surface, then e_o should be taken as $e_o = r_1\ \phi \cos\phi$.



1 mast axis

2 area of compression zone

Figure 6.2 (CYS): Eccentricities due to the inclination of the mast base

NA 2.18 Clause 7.1(1) Basis

The value of γ_M is specified as 1,0

NA 2.19 Clause 9.5(1) Partial factors for fatigue

The value of γ_{Ff} is specified as 1,00.

The values for γ_{Mf} are given in Table 3.1 (CYS) of the National Annex of CYS EN 1993-1-9, which is repeated below

Table 3.1 (CYS): Values for partial factors for fatigue strength

Assessment method	Consequence of failure	
	Low consequence	High consequence
Damage tolerant	1,00	1,15
Safe life	1,15	1,35

NA 2.20 Clause A.1(1) Reliability differentiation for masts and towers

Table A.1 (CYS) provides relevant reliability classes related to the consequences of structural failure.

Table A.1 (CYS): Reliability differentiation for towers and masts

Reliability Class	
3	towers and masts erected in urban locations, or where their failure is likely to cause injury or loss of life; towers and masts used for vital telecommunication facilities; other major structures where the consequences of failure would be likely to be very high
2	all towers and masts that cannot be defined as class 1 or 3
1	towers and masts built on unmanned sites in open countryside; towers and masts, the failure of which would not be likely to cause injury to people

NA 2.21 Clause A.2(1)P Partial factors for actions

Table A.2 (CYS) provides numerical values of γ_G and γ_Q.

Table A.2 (CYS): Partial factors for permanent and variable actions

Type of Effect	Reliability Class	Permanent Actions	Variable Actions (Qs)
unfavourable	3	1,2	1,6
	2	1,1	1,4
	1	1,0	1,2
favourable	All Classes	1,0	0,0
Accidental situations		1,0	1,0

No information is provided on the use of dynamic response analysis for wind actions.

NA 2.22 Clause B.1.1(1) Scope of this Annex

No further information is provided on ice loading.

NA 2.23 Clause B.2.1.1(5) Outline

No information is provided on wind tunnel tests.

NA 2.24 Clause B.2.3(1) Wind force coefficients of linear ancillaries

Table B.1 (CYS) provides values for the typical Drag (pressure) coefficient $c_{f,A,0}$ for common isolated individual components.

Table B.1 (CYS): Typical force coefficients, $c_{f,A,0}$ and $c_{f,G}$, for individual components

Member type	Effective Reynold's number Re (see EN 1991-1-4) (see **NOTE 1**)	Drag (pressure) coefficient $c_{f,A,0}$ or $c_{f,G}$	
		Ice-free	Iced
(a) Flat-sided sections and plates	All values	2,0	2,0
(b) Circular sections and smooth wire	≤ 2 x 10^5	1,2	1,2
	4 x 10^5	0,6	1,0
	> 10 x 10^5	0,7	1,0
(c) Fine stranded cable, e.g. steel core aluminium round conductor, locked coil ropes, spiral steel strand with more than seven wires	Ice free: ≤ 6 x 10^4 ≥ 10^5	 1,2 0,9	
	Iced: ≤ 1 x 10^5 ≥ 2 x 10^5		 1,25 1,0
(d) Thick stranded cable, e.g. small wire ropes, round strand ropes, spiral steel strand with seven wires only (1 x 7)	Ice free: ≤ 4 x 10^4 > 4 x 10^4	 1,3 1,1	
	Iced: ≤ 1 x 10^5 ≥ 2 x 10^5		 1,25 1,0
(e) Cylinders with helical strakes of depth up to 0.12*D* (see **NOTE 2**)	All values	1,2	1,2

NOTE 1: For intermediate values of Re, $c_{f,A,0}$ should be obtained by linear interpolation.
NOTE 2: These values are based on the overall width, including twice the strake depth.
NOTE 3: The values for iced components are relevant for glazed ice; care should be exercised if they are used for rime ice (see ISO 12494).

NA 2.25 Clause B.2.3(3) Wind force coefficients of linear ancillaries

Table B.2 (CYS) provides values for the reduction factor K_A for ancillary items.

Table B.1 (CYS): Reduction factor, K_A, for ancillary items

Position of ancillaries	Reduction factor, K_A	
	Square or rectangular plan form	Triangular plan form
Internal to the section	0,8	0,8
External to the section	0,8	0,8

NA 2.26 Clause B.3.2.2.6(4) Wind loading for unsymmetrical towers or towers with complex attachments

The value of K_X for crosswind intensity of turbulence is specified as 1,0.

NA 2.27 Clause B.3.3(1) Spectral analysis method

No further information is provided.

NA 2.28 Clause B.3.3(2) Spectral analysis method

No further information is provided.

NA 2.29 Clause B.4.3.2.2(2) Patch loads

The value of the scaling factor k_s is specified as 2,95.

NA 2.30 Clause B.4.3.2.3(1) Loading on guys

The value of the scaling factor k_s is specified as 2,95.

NA 2.31 Clause B.4.3.2.8.1(4) General

The value of K_X for cross wind intensity of turbulence is specified as 1,0.

NA 2.32 Clause C.2(1) Ice loading

No further information is provided.

NA 2.33 Clause C.6(1) Combinations of ice and wind

The combination factors are specified as

$$\psi_W = 0,5 \quad \text{... (C.3a (CYS))}$$

$$\psi_{ice} = 0,5 \quad \text{... (C.3b (CYS))}$$

NA 2.34 Clause D.1.1(1) Metallic guys and tension elements

No further information is provided.

NA 2.35 Clause D.1.2(2) Non metallic guys

No further information is provided.

NA 2.36 Clause D.3(6) Insulators

No further information is provided.

NA 2.37 Clause D.4.1(1) Ladders, platforms, etc.

No further information is provided.

NA 2.38 Clause D.4.2(3) Lightning protection

No further information is provided.

NA 2.39 Clause D.4.3(1) Aircraft warning

No further information is provided.

NA 2.40 Clause D.4.4(1) Protection against vandalism

No further information is provided.

NA 2.41 Clause F.4.2.1(1) Lattice towers

The maximum displacement of the tower top is specified as not more than $^1/_{500}$ of the height of the tower.

NA 2.42 Clause F.4.2.2(2) Guyed masts

The following values for tolerances are specified:

a) The final position of the centre line of the mast should all lie within a vertical cone with its apex at the mast base and with a radius of $^1/_{1500}$ of the height above the mast base. This does not apply to halyards or aerial array wires.

b) The resultant horizontal component of the initial guy tensions of all the guys at a given level should not exceed 5 % of the average horizontal component of the initial guy tension for that level. The initial tension in any individual guy at a given level should in no case vary more than 10 % from the design value, see CYS EN 1993-1-11.

c) Maximum initial deflection of the mast column between two guy levels, where L is the distance between the guy levels in question, should be L/1000.

d) After erection the tolerance on the alignment of 3 consecutive guy connections on the shaft is limited to $(L_1 + L_2)/2000$, where L_1 and L_2 are the lengths of the two consecutive spans of the shaft.

NA 2.43 Clause G.1(3) Buckling resistance of compression members

The reduction factor η for the design buckling resistance is specified as

$\eta = 0,8$ for single angle members connected by one bolt at each end;

$\eta = 0,9$ for single angle members connected by one bolt at one end and continuous or rigidly connected at the other end.

NA 2.44 Clause H.2(5) Leg members

No further information is provided.

NA 2.45 Clause H.2(7) Leg members

No further information is provided.

NA 3 DECISION ON USE OF THE INFORMATIVE ANNEXES

NA 3.1 Annex B

Annex B may be used

NA 3.2 Annex C

Annex C may be used

NA 3.3 Annex E

Annex E may be used

NA 3.4 Annex F

Annex F may be used

NA 3.5 Annex G

Annex G may be used

NA 3.6 Annex H

Annex H may be used

NA 4 REFERENCES TO NON-CONTRADICTORY COMPLEMENTARY INFORMATION

None

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NA to CYS EN 1993-3-1:2006 (Including AC:2009)

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