ANNEX 24

NATIONAL ANNEX

TO STANDARD

SFS-EN 1993-3-1 EUROCODE 3: DESIGN OF STEEL STRUCTURES.

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

Preface

This national annex is used together with Standard SFS - EN 1993-3-1:2006.

This national annex sets out:

a) The national parameters for the following clauses in Standard SFS-EN 1993-3-1 where national selection is permitted:

2.1.1(3)P	7.1(1)	D.3(6) (2 places)
2.3.1.(1)	9.5(1)	D.4.1(1)
2.3.2(1)	A.1(1)	D.4.2(3)
2.3.6(2)	A.2(1)P(2 places)	D.4.3(1)
2.3.7(1)	B.1.1(1)	D.4.4(1)
2.3.7(4)	B.2.1(5)	F.4.2.1(1)
2.5(1)	B.2.3(1)	F.4.2.2(2)
2.6(1)	B.3.2.2.6(4)	G.1(3)
4.1(1)	B.3.3(1)	H.2(5)
4.2(1)	B.3.3(2)	H.2(7).
5.1(6)	B.4.3.2.2(2)	
5.2.4(1)	B.4.3.2.3(1)	
6.1(1)	B.4.3.2.8.1(4)	
6.3.1(1)	C.2(1)	
6.4.1(1)	C.6.(1)	
6.4.2(2)	D.1.1(1)	
6.5.1(1)	D.1.2(2)	

b) Guidance for the use of Annexes A, B, C, D, F, G and H.

2.1.1 Basic requirements

2.1.1(3)P:
The guidance in Annex E may be used.

2.3.1 Wind actions

2.3.1(1):
The rules in Annex B should be used. Additional rules in National Annex for SFS-EN 1991-1-4 should be considered also. However, the formula 4.5 of SFS-EN 1991-1-4 should not be used for the terrain category 0 (offshore areas) and the terrain factor for that category in table 4.1 shall be taken as $k_T = 0{,}18$ ($z_0 = 0{,}003$).

2.3.2 Ice loads

2.3.2(1):
The rules in Annex C shall be considered. The values of the ice loads and the combinations of wind and ice with associated combination factors are given in Annex C of this National Annex.

2.3.6 Imposed loads

2.3.6(2), Note 1:

The recommended values for platforms and railings should be used.

In slender structures, where the loads caused by persons may affect on the design of the structural components, the structure should be checked in erection or maintenance situations for the load combination taking into account following actions:

- Reduced wind load (no ice), temperature 0° C
- Person in the mast (at unfavourable location), characteristic weight 1 kN, effective wind area 1,0 m^2
- Equivalent horizontal characteristic force from movements of a person 0,5 kN
- Other erection/maintenance loads existing at the situation (loads from hoist etc)

In the calculation of the wind pressure the parameters of terrain type II for flat terrain should be applied independently on the real type or shape of the terrain at the site. The load combination can be expressed with the following formula (ref. to formulae C.1 and C.2):

$$\gamma_G G_k + \gamma_E Q_{k,E} + \gamma_W \psi_W Q_{k,w} \qquad (2.1\ \text{FI})$$

where:
- G_k is characteristic value for self-weights of the structure and permanent ancillaries
- $Q_{k,E}$ is characteristic value for actions due to erection works, persons etc.
- $Q_{k,w}$ is characteristic value for wind actions (incl. wind loads due to persons)
- γ_G is partial load factor for self weight, $\gamma_G = 1{,}15$
- γ_E is partial load factor for erection actions, $\gamma_E = 1{,}5$
- γ_W is partial load factor for wind actions, $\gamma_W = 1{,}5$
- ψ_W is combination factor for wind, $\psi_W = 0{,}5$

2.3.7 Other actions

2.3.7(1):
No further information is given.

2.3.7(4):

The loads due to the erection of a mast should be taken into account in the design (i.e. erection by a derrick or a crane, pre-tensioning of guys etc.).

In the erection of a guyed mast, where any span between two adjacent guy levels is installed, the case where the guys at the upper guy level are not yet installed, should be checked. The load combination can be expressed with the following formula (ref. to formulae C.1 and C.2):

$$\gamma_G G_k + \gamma_W \psi_W Q_{k,w} \tag{2.2 FI}$$

where:
- G_k is characteristic value for self weights of the structure and ancillaries,
- $Q_{k,w}$ is characteristic value for wind actions,
- γ_G is partial load factor for self-weight, (see Table A.2)
- γ_W is partial load factor for wind actions, (see Table A.2)
- ψ_W is combination factor for wind, $\psi_W = 0,4$.

2.5 Design assisted by testing

2.5(1):
No further information is given.

2.6 Durability

2.6(1):
The recommended design life of important broadcasting and telecommunication towers and masts is 50 years. The design life of other towers and masts (i.e. structures for mobile network base stations or lightning towers etc.) is 30 years. The design lifetime should also be given in the Project Specification. The design lifetime for fatigue should be determined according to SFS-EN 1993-1-9 and its National Annex.

4.1 Allowance for corrosion

4.1(1), Note 1:
See also SFS-EN ISO 10684 for galvanizing of bolts.

4.2 Guys

4.2(1):
When assessing the need of possible protection measures, the design life of the structure should be taken into account. The change of the guys can be considered as an alternative instead of the protection methods recommended above.

5.1 Modelling for determining action effects

5.1(6):
No further information is given.

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

5.2.4(1):
No further information is given.

6.1 General

6.1(1), Note 1:

Following γ_M values should be used.

The resistance of the guy assembly (guy with end fittings) should be at least 90 % of the resistance of the straight guy. Mostly the decrease of the strength will be caused by the bending of the guy wire around the fittings (wedge clamp or thimble).

$\gamma_{M0} = 1,00$
$\gamma_{M1} = 1,00$
$\gamma_{M2} = 1,25$
$\gamma_{Mg} = 1,50$
$\gamma_{Mi} = 2,00$.

6.3.1 Compression members

6.3.1(1), Note 2:
Either of the procedures a) or b) may be used.

6.4.1 General

6.4.1(1):
The recommended values should be used.

6.4.2 Tension bolts in end plates (flanged connections)

6.4.2(2):
No further information is given.

6.5.1 Mast base joint

6.5.1(1):
No further information is given.

7 Serviceability limit states

7.1 Basis

7.1(1):
The allowable values for the deformations should be defined in the Project Specification. The calculations should be done for reduced wind loads without ice, if other additional requirements are not specified in the Project Specification. If the patch load method is used in the design of a guyed mast, it should be applied also to the deformation analysis in the serviceability limit state.

The load combination can be expressed with the formula 7.1 FI (ref. to formulae C.1 and C.2), where

$$\gamma_G\, G_k + 0,64\, \gamma_W\, Q_{k,w} \qquad (7.1\ \text{FI})$$

where G_k is characteristic value for self weights of the structure and ancillaries
$Q_{k,w}$ is characteristic value for wind actions
γ_G is partial load factor for self weight, $\gamma_G = 1,0$
γ_W is partial load factor for wind actions, $\gamma_W = 1,0$.

For the partial safety factor of materials the recommended value for $\gamma_M = 1,0$ should be used.

9.5 Partial factors for fatigue

9.5(1):
The recommended values according to the National Annex of SFS-EN 1993-1-9 should be used.

Annex A
Reliability differentiation and partial factors for actions

A.1 Reliability differentiation for masts and towers

A.1(1):
The classes in Table A.1 (FI) should be used.

Table A.1 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

A.2 Partial factors for actions

A.2(1)P, Note 2:

The values of γ_G and γ_Q should be taken from the (revised) Table A.2 (FI).

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

Type of effect	Reliability class	Permanent actions	Variable actions
Unfavourable	3	1,2	1,4
	2	1,1	1,2
	1	1,0	1,1
Favourable	All classes	1,0	0,0
Accidental situations		1,0	1,0

A.2(1)P, Note 3:
No further information is given.

Annex B
Modelling of meteorological actions

Annex B may be used.

B.1.1(1):
No further information is given for this clause (for ice loads, see Annex C).

B.2.1.1(5):
No further information is given.

B.2.3(1): Note 4 of Table B.2.1 and Note of Table B.2.2:
The values of the coefficients in Tables B.2.1 and B.2.2 should be used.

B.3.2.2.6(4), Note 1:
The recommended value of the coefficient K_X =1,0 should be used.

B.3.3(1):
No further information is given.

B.3.3(2):
No further information is given.

B.4.3.2.2(2), Note 2:
The recommended value of the factor k_s = 3,5 should be used.

B.4.3.2.3(1), Note 2:
The recommended value of the factor k_s =3,5 should be used.

B.4.3.2.8.1(4), Note 1:
The recommended value of the coefficient K_X = 1,0 should be used.

Annex C
Ice loading and combinations of ice with wind

Annex C may be used.

C.2 Ice loading

C.2(1):
The type of the ice on tower and mast structures in Finland is rime ice, see ISO 12494, clause 7.5.

The determination of the ice class at a certain height should be done by utilizing sufficiently long term icing statistics, which are possibly available from the site area. Co-operation with a meteorologist familiar with icing is recommended.

The mast structure should be divided vertically in sections with a maximum height of 100 m. The ice class will be defined for each section by using the height level at the 2/3 of the height of the section measured from the bottom of the section.

The ice class for a guy can be assumed to be constant on the whole length of the guy. The ice class is defined at a height of 2/3 of the height of the guy attachment level at the mast.

If no better information is available the following assumptions may be used:

- The ice class and the relevant ice weight on structural elements at a certain height are defined according to table Fi.C.2.1 in this NA. The values in the table are based on the ice density of 300 kg/m^3 for the elements in the mast shaft and 400 kg/m^3 for the guys.
- When calculating the thickness of the ice deposit on an element in a tower or mast for the determination of the effective wind area, the principles of ISO 12494 are recommended to be used. An alternative simplified method is given in clause C.6

For masts in reliability class 3 with ice class R6 or higher the eccentric ice in the shaft and asymmetrical icing of the guys should be considered. The centre of the eccentric shaft ice is assumed to be at a distance of 0,5 times the shaft width from the shaft centre in the most unfavourable direction in each load case for the structural element concerned. In the cases for asymmetrical icing of the guys, one or more guys can be without ice according to the Table Fi.C.2.3 in this NA.

The force coefficient for iced single elements and guys can be obtained from Tables 17 to 25 of ISO 12494 (see also Table B.2.1 in Annex B). The force coefficient of an iced lattice shaft is based on the solidity ratio of the mast faces according to annex B. The parameters concerning a lattice structure composed of flat-sided elements should be used in all cases. The force coefficient for a lattice structure with all faces completely filled with ice depends on the ice class according to the Table C.2.2 (FI) in this NA.

The ice load of a fully iced lattice shaft is defined through the thickness of the ice deposit given in the Project Specification or calculated from the formula Fi.C.5 (value $T_{i,g}$) assuming symmetric icing.

Falling ice should be considered according to ISO 12494, Chapter 11.

Table C.2.1 (FI) Ice loads and k factors in different ice classes

Ice class	H (m)	G_i (kg/m)	k
R1	0 - 50	0,5	0,40
R2	50 - 100	0,9	0,45
R3	100 - 150	1,6	0,50
R4	150 - 200	2,8	0,55
R5	200 - 250	5,0	0,60
R6	250 - 300	8,9	0,70
R7	300 - 350	16,0	0,80
R8	350 - 400	28,0	0,90
R9	400 - 450	50,0	1,00

H is the relative height from the average level of the surrounding terrain within the distance of 10 km from the site

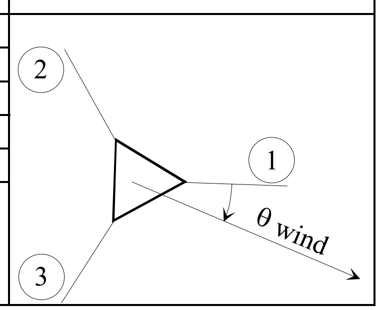
G_i is the characteristic unit weight of the ice on the element

k is the reduction factor in load combinations for wind and ice (see Clause C.6). piste

Table C.2.2 (FI) Force coefficient $C_{f,S,0,i}$ for fully iced lattice shaft

Ice class	Force coefficient for fully iced shaft $C_{f,S,0,i}$	
	⇨ □ ▷ ◁	⇨ ◇
R1 - R3	2,0	1,8
R4 - R5	1,8	1,6
R6 - R7	1,6	1,4
R8 – R9	1,4	1,2
Wind drag is calculated to the area projected perpendicular to wind		

Table C.2.3 (FI) Unsymmetrical ice loads for guys. N is the number of guy level.

Case	Wind direction	Guys without ice	Wind and guy directions
1	180	All guys of direction 1	
2	0	All guys of directions 2 and 3	
3	0	Guys of directions 2 and 3 in guy level 1	
Na	0	1_N , 2_{N-1} , 3_{N-1}	
Nb	0	1_N , 2_{N-1} , 3_{N-1} , 2_{N+1} , 3_{N+1}	
Key: 2_{N-1} refers to guy in direction 2 in guy level N-1			

C.6 Combinations of ice and wind

C.6(1):
The values for the reduction factor k defined in ISO 12494 are reviewed in Table Fi.C.2.1 in this NA. Following combination factors should be used in Finland:

$\psi_w = 0{,}5$ (C.3a FI)
$\psi_{ice} = 0{,}3.$ (C.3b FI)

The wind area of an iced element or linear ancillary should be calculated using following design values for ice weight:

$G_{i,d} = \gamma_{ice} G_i$ in formula (C.1) (C.4a FI)
$G_{i,d} = \gamma_{ice} \psi_{ice} G_i$ in formula (C.2). (C.4b FI)

The ice thickness used in the calculation of the wind area of an element can be determined alternatively instead of methods in ISO 12494 using simplified methods with the formula Fi.C.5. The thickness of the ice deposit is assumed to be constant on each side of the element. Symbols:

$T_{i,s}$ is the thickness of the ice deposit on an element or ancillary in the lattice structure
$T_{i,g}$ is the thickness of the ice deposit on a guy
$G_{i,d}$ is the design value of the ice weight (G_i will be taken from table C.2.1 FI)
ρ_i is the density of the ice
B is the width of the element or the diameter of the guy without ice.

The formula Fi.C.5 is valid for elements with $B \leq 300$ mm. For larger elements and compact tubular shafts the ISO 12494 method for single elements should be used. The difference between the values $T_{i,g}$ and $T_{i,s}$ is due to the symmetric icing on the guy.

Temperatures in different load conditions:

- Reference condition (no wind, no ice) 0° C
- Wind, no ice -20° C
- Wind and ice (all combinations) 0° C.

The temperature should be taken into account, when determining the air density for the wind pressure.

Annex D
Guys, dampers, insulators, ancillaries and other items

D.1.1(1):
Rope safety clamps should not be used for the attachments of the guy ropes.

D.1.2(2):
No further information is given.

D.3(6), Note 1:
The breakage of a guy insulator shall not cause the collapse of the mast.

D.3(6), Note 2:
No further information is given.

D.4.1(1):
No further information is given.

D.4.2(3):
The leg joints of the structure shall be provided with a good galvanic connection. The towers and masts should be equipped with a ground wire (minimum size 25 mm^2 copper or 50 mm^2 steel) from the top to the base of the structure. It shall be connected to the underground radial earthing net, which should fulfil the appropriate requirements of the authorities and the client.

D.4.3(1):
The structure considered as an aviation obstruction should be painted with obstruction colours and/or equipped with obstruction lights according to requirements of ICAO and national aviation authority.

Details are given in the decision nr 1/2000 of the Finnish Civil Aviation Administration. The details on the markings can be found in the aviation regulation AGA M3-6.

D.4.4(1):
No further information is given.

Annex E
Guy rupture

Annex E may be used.

Annex F
Fabrication and erection

F.4.2.1(1):
The recommended value should be used.

F.4.2.2(2):
The recommended values should be used.

Annex G
Buckling of components of masts and towers

Annex G may be used.

G.1(3):
The recommended values should be used.

Annex H
Buckling length and slenderness of members

Annex H may be used.

H.2(5):
No further information is given.

H.2(7), Note 2:
No further information is given.