Social- og Boligstyrelsen
Danish Authority of Social Services and Housing

DS/EN 1993-3-1 DK NA:2019

National Annex to
Eurocode 3: Design of steel structures –
Part 3-1: Towers, masts and chimneys – Towers and masts

Foreword

This National Annex (NA) is a revision of DS/EN 1993-3-1 DK NA:2013 and replaces the latter as from 2019-09-09. For a transition period until 2019-12-31, this National Annex as well as the previous National Annex will be applicable.

Text has been added under Clause 6.1(1) Ultimate limit states – General in relation to level of checking.

This NA lays down the conditions for the implementation in Denmark of EN 1993-3-1 for construction works in conformity with the Danish Building Regulations.

This NA applies to construction works covered by section 16(1) of the Danish Building Regulations as well as to construction works covered by sections 24 to 27 of the Danish Building Regulations.

This NA specifies the national choices prescribed in Denmark.

This NA includes:

- an overview of possible national choices and clauses containing complementary information;
- national choices;
- (non-contradictory) complementary information which may assist the user of the Eurocode.

For structures covered by sections 24 to 27 of the Danish Building Regulations BR18, or not covered by the Danish Building Regulations, levels of checking may still be used for the calculation of structures in ultimate limit states. For structures covered by section 16(1) of the Danish Building Regulations, levels of checking cannot be applied.

Overview of possible national choices and complementary information

The list below identifies the clauses where national choices are possible and the applicable/not applicable informative annexes. Furthermore, clauses giving complementary information are identified. Complementary information is given at the end of this document.

Clause	Subject	National choice [1)]	Complementary information[2)]
2.1.1(3)P	Basis of design - Basic requirements	National choice	
2.3.1(1)	Wind actions	National choice	
2.3.2(1)	Ice loads	National choice	
2.3.6(2)	Imposed loads	National choice	
2.3.7(1)	Other actions – Accidental actions	No further information	
2.3.7(4)	Other actions	No further information	
2.5(1)	Design assisted by testing	No further information	
2.6(1)	Durability	National choice	
4.1(1)	Corrosion protection – Allowance for corrosion	No further information	
4.2(1)	Guys	Unchanged	Complementary information
5.1(6)	Modelling for determining action effects	No further information	
5.2.4(1)	Triangulated structures where continuity is taken into account (continuous or semi-continuous framing)	No further information	
6.1(1)	Ultimate limit states - General	National choice	
6.3.1(1)	Resistance of members	National choice	
6.4.1(1)	Connections - General	Unchanged	Complementary information
6.4.2(2)	Tension bolts in end plates (flanged connections)	National choice	Complementary information
6.5.1(1)	Mast base joint	No further information	
7.1(1)	Serviceability limit states - Basis	Unchanged	
9.5(1)	Partial factors for fatigue	National choice	
A.1(1)	Reliability differentiation for masts and towers	National choice	
A.2(1)P (2 occurrences)	Partial factors for actions	National choice	

Clause	Subject	National choice [1)]	Complementary information[2)]
B.1.1(1)	Modelling of meteorological actions - General	No further information	
B.2.1.1(5)	Wind force - General	No further information	
B.2.3(3)	Wind force coefficients of linear ancillaries	Unchanged	
B.3.2.2.6 (4)	Wind loading for unsymmetrical towers or towers with complex attachments	Unchanged	
B.3.3(1)	Spectral analysis method	No further information	
B.3.3(2)	Spectral analysis method	No further information	
B.4.3.2.2(2)	Patch loads	Unchanged	
B.4.3.2.3(1)	Loading on guys	Unchanged	
B.4.3.2.8.1 (4)	Wind loading for unsymmetrical masts or masts with complex attachments	Unchanged	
C.2(1)	Ice loading	National choice	
C.6(1)	Combinations of ice and wind	National choice	
D.1.1(2)	Metallic guys and tension elements	National choice	
D.1.2(2)	Non-metallic guys	No further information	
D.3(6) (2 occurrences)	Insulators	No further information	
D.4.1(1)	Ladders, platforms, etc.	No further information	
D.4.2(3)	Lightning protection	No further information	
D.4.3(1)	Aircraft warning	No further information	
D.4.4(1)	Protection against vandalism	No further information	
F.4.2.1(1)	Lattice towers	Unchanged	
F.4.2.2(2)	Guyed masts	Unchanged	
G.1(3)	Buckling resistance of compression members	Unchanged	
H.2(5)	Leg members – Built–up members	No further information	
H.2(7)	Leg members - Battens	No further information	

1)
Unchanged: Recommendations in the Eurocode to be followed.
National choice: A national choice has been made.
No further information: The Eurocode allows further information. No further information is given.

2)
Complementary information: Non-contradictory, complementary information on how to use the Eurocode. No complementary information is given.

National choices

2.1.1(3)P Basis of design – Basic requirements
Annex E is applied.

2.3.1(1) Wind actions
The Annex is applied with the following amendment:

The structural factor, $c_s c_d$, is determined according to Procedure 2 in EN 1991-1-4.
The equations given in Annex B.3.2 are applicable only for flat terrain where the orography factor, c_0, is equal to 1.

Structural vibrations due to rhythmic vortex shedding are determined according to Procedure 2 in EN 1991-1-4.

2.3.2(1) Ice loads
Annex C is applied.

2.3.6(2) Imposed loads
The characteristic values for imposed loads, q_k, (evenly distributed surface or line load) and Q_k (point loads) in Table 2.1 DK NA, are applied:

Table 2.1 DK NA Characteristic values for imposed loads

Category	q_k [kN/m^2]	q_k [kN/m]	Q_k [kN]
Ladders			1,5 vertical 0,5 horizontal
Platforms and foot-bridges	1,5		1,5 distributed over 150·150mm^2
Handrails		0,5 horizontal	1,5 vertical

with $\psi_0 = 0{,}5$.

2.6(1) Durability
The design life is 30 years for structures belonging to CC1 and CC2, and 50 years for structures belonging to CC3 (and CC3+).

6.1(1) Ultimate limit states - General
Partial factors for strength parameters and resistances are determined using the following expressions:

$$\gamma_{M0} = 1{,}1 \cdot \gamma_3$$
$$\gamma_{M1} = 1{,}2 \cdot \gamma_3$$
$$\gamma_{M2} = 1{,}35 \cdot \gamma_3$$
$$\gamma_{MG} = 2{,}0 \cdot \gamma_3$$
$$\gamma_{Mi} = 2{,}5 \cdot \gamma_3$$

NOTE: The partial factors specified are based on the assumption that only load combination 2 in Table A1.2(B+C) NA in DK NA 1990 is relevant for the design of masts for persistent and transient design situations.

The factor γ_3 takes into account the level of checking of the product. The reduced level of checking is not used.

Extended level of checking: $\gamma_3 = 0{,}95$
Normal level of checking: $\gamma_3 = 1{,}00$

For structures covered by section 16(1) of the Danish Building Regulations, the extended level of checking cannot be applied, and γ_3.is taken as 1,00.

The partial factors are determined in accordance with the National Annex to EN 1990, Annex F, where $\gamma_M = \gamma_1 \gamma_2 \gamma_3 \gamma_4$.

γ_1	takes into account the type of failure;
γ_2	takes into account the uncertainty related to the design model;
γ_3	takes into account the extent of checking;
γ_4	takes into account the variation of the strength parameter or resistance.

When determining γ_1, the following types of failure have been assumed:

γ_{M0}	Warning of failure with residual resistance
γ_{M1}	Warning of failure without residual resistance
γ_{M2}, γ_{MG}, γ_{Mi}	No warning of failure

For accidental and seismic design situations the following values are used:

$\gamma_{M0} = 1{,}0$
$\gamma_{M1} = 1{,}0$
$\gamma_{M2} = 1{,}0$
$\gamma_{MG} = 1{,}0$
$\gamma_{Mi} = 1{,}0$

6.3.1(1) Resistance of members
The methods in both a) and b) can be used.

6.4.2 Tension bolts in end plates (flanged connections)
NOTE: The method specified for the verification of flanged connections is conservative, and alternative methods applying yield line analogy are allowed.

For non-preloaded bolts a prying effect factor, k_p of 1,20 may be used.

See also the complementary information.

9.5(1) Partial factors for fatigue
The partial factor, γ_{Mf}, in Table 9.1 DK NA is applied:

Table 9.1 DK NA Partial factor γ_{Mf} for fatigue

Assessment method	CC1	CC2	CC3
Damage tolerant	1,00	1,00	1,00
Safe life	1,26	1,54	1,88

A.1(1) Reliability differentiation for masts and towers
Consequences classes CC1, CC2 and CC3 correspond to reliability classes RC1, RC2 and RC3, respectively.

NOTE to Table A.1: For masts assigned to reliability class RC2, failure will involve only a small risk of loss of human life. The majority of masts, e.g. mobile network masts not placed close to built-up and public areas may be assigned to reliability class RC1 (CC1).

A.2(1)P Partial factors for actions
The partial factors specified in Table A.2 DK NA are applied for permanent and variable actions.

NOTE: Normally, only load combination 2 in DK NA 1990 is relevant for the design of masts for persistent and transient design situations.

Table A.2 NA Partial factors for permanent and variable actions

Type of loading	Consequences class	Permanent actions	Variable actions	
			Leading	Accompanying
Unfavourable	CC3	1,1	1,6	$\psi_0 \cdot 1{,}6$
	CC2	1,0	1,4	$\psi_0 \cdot 1{,}4$
	CC1	0,9	1,2	$\psi_0 \cdot 1{,}2$
Favourable	All classes	0,9	0,0	0,0
Accidental actions		1,0	1,0	0,0

Design values for fatigue actions are determined using the provisions given in DS/EN 1990 DK NA.

In all cases, the partial factor for guy tensioning is taken as 1,0.

C.2(1) Ice loading
Classes ICG1 and ICR2 are applied in Denmark.

C.6(1) Combinations of ice and wind
For wind, ψ_0 is specified in DS/EN 1990 DK NA
For ice, $\psi_0 = 0{,}3$.

D.1.1(2) Metallic guys and tension elements
D.1.1(2) is deleted as it is incorrect to refer to antennas.

(Non-contradictory) complementary information

4.2(1) Guys
Depending on the surrounding environment, guys should be surface treated by hot dipping in zinc or zinc aluminium, and the thickest coating possible should be chosen. The life can be extended by ensuring that the guy cross section is completely closed by means of a suitable product. Reference is made to EN 12385 *Steel wire ropes - Safety - Part 1:General requirements.*

Normally, protection by polypropylene coatings or equivalent cannot be recommended.

6.4.1(1) Connections - General
For the determination of partial factors for connections, reference is made to the National Annex to DS/EN 1993-1-8.

6.4.2 Tension bolts in end plates (flanged connections)
NOTE: The note in the present edition contains an error. At the meeting on 2012-09-21 of the CEN/TC 250 SC3 working group on updating of EN 1993-3-1, it was agreed that the requirement for preloaded bolts should apply only to structures subject to fatigue.