

NA to BS EN 1993-3-1:2006



BSI Standards Publication

UK National Annex to Eurocode 3: Design of steel structures

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

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ISBN 978 0 580 55088 1

ICS 91.010.30; 91.080.10

The following BSI references relate to the work on this standard:

Committee reference B/525/32

Draft for comment 09/30129886 DC

Publication history

First published, March 2010

Amendments issued since publication

Date	Text affected
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Summary of pages

This document comprises a front cover, an inside front cover, pages 1 to 22, an inside back cover and a back cover.

National Annex NA (informative) to BS EN 1993-3-1:2006, Eurocode 3 – Design of steel structures – Part 3-1: Towers, masts and chimneys – Towers and masts

Introduction

This National Annex has been prepared by BSI Subcommittee B/525/32, *Towers and masts*. It is to be used in conjunction with BS EN 1993-3-1:2006+C1:2009.

The content of this National Annex to BS EN 1993-3-1 is critically dependent on the content and formulation for wind actions in the National Annex to BS EN 1991-1-4, *Wind actions*, which was published in October 2008. However, there has been no National Calibration Period, as envisaged in Guidance Paper L [1], and the co-existence period before withdrawal of the National Standard (BS 8100) has been curtailed from the minimum three years specified in Guidance Paper L [1]. Therefore, no calibration studies have yet been undertaken on BS EN 1993-3-1 and its National Annex. It is therefore strongly recommended that, in using these documents, design is undertaken using recognized documents in parallel with these.

It is an assumption of this NA that all structures will be maintained in accordance with the minimum requirements of their designers. Recommended content for a maintenance manual providing this information is given in PD 6695-3-1 (in preparation).

NA.1 Scope

This National Annex gives:

- a) the UK decisions for the Nationally Determined Parameters described in the following subclauses of BS EN 1993-3-1:2006:
- | | | |
|------------------|--------------------|--------------------|
| — 2.1.1(3)P Note | — 6.4.2(2) | — B.4.3.2.8.1(4) |
| — 2.3.1(1) | — 6.5.1(1) | — C.2(1) |
| — 2.3.2(1) | — 7.1(1) | — C.6(1) |
| — 2.3.6(2) | — 9.5(1) | — D.1.1(1) |
| — 2.3.7(1) | — A.1(1) | — D.1.2(2) |
| — 2.3.7(4) | — A.2(1) (2 times) | — D.3(6) (2 times) |
| — 2.5(1) | — B.1.1(1) | — D.4.1(1) |
| — 2.6(1) | — B.2.1.1(5) | — D.4.2(3) |
| — 4.1(1) | — B.2.3(1) | — D.4.3(1) |
| — 4.2(1) | — B.2.3(3) | — D.4.4 (1) |
| — 5.1(6) | — B.3.2.2.6(4) | — F.4.2.1(1) |
| — 5.2.4(1) | — B.3.3(1) | — F.4.2.2(2) |
| — 6.1 (1) | — B.3.3(2) | — G.1(3) |
| — 6.3.1(1) | — B.4.3.2.2(2) | — H.2(5) |
| — 6.4.1(1) | — B.4.3.2.3(1) | — H.2(7) |

- b) the UK decisions on the status of BS EN 1993-3-1:2006 informative annexes B, C, E, F, G and H (see **NA.3**); and
- c) references to non-contradictory complementary information (see **NA.4**).

NA.2 Nationally determined parameters

NA.2.1 Guy rupture [BS EN 1993-3-1:2006, 2.1.1(3)P Note]

The procedure recommended in BS EN 1993-3-1:2006, Annex E, should be used.

NA.2.2 How BS EN 1991-1-4 should be supplemented for masts and towers [BS EN 1993-3-1:2006, 2.3.1(1) Note]

The procedure recommended in BS EN 1993-3-1:2006, Annex B, should be used, with the following modifications.

BS EN 1993-3-1:2006, Annex B, makes reference to BS EN 1991-1-4 for parameters to define the wind structure to be used. The formulation in the UK National Annex to BS EN 1991-1-4 modifies the parameter to define peak pressures by adopting a “peak factor” of 3,0 with a quadratic equation, rather than 3,5 with a linear equation, as used in BS EN 1991-1-4. The decision to change the formulation was due to the use of the ten minute wind speed in BS EN 1991-1-4 and the greater accuracy in the quadratic expression.

As a consequence of this, equations B14a, B14b, B15, B16, B17, B22, B23, B24 and B25 in Annex B need to be amended as follows for use in the UK, for which the National Annex to BS EN 1991-1-4 is required.

Replace $1 + 7I_v(z)$ in each of equations B14a to B17 and B22 to B25 with $[1 + 3,0I_v(z)]^2$.

The value of k_s in BS EN 1993-3-1:2006, **B.4.4(2)** (spectral analysis method only), may be taken as 2,95.

The scope of BS EN 1991-1-4 is limited to 200 m in height, and the wind structure parameters $c_r(z)$, $c_{r,T}$, $I_v(z)_{\text{flat}}$, $k_{l,T}$, $c_e(z)$, $c_{e,T}$ given in Figures NA.3 to NA.8, respectively, of the National Annex to BS EN 1991-1-4 are only provided up to 200 m.

For the design of towers and masts taller than 200 m the values for these parameters are given on the IStructE website at <http://www.istructe.org/eurocodes/windukdata.asp> (see Annex A.NA.1.2).

NA.2.3 Ice loading [BS EN 1993-3-1:2006, 2.3.2(1)]

The procedure recommended in BS EN 1993-3-1:2006, Annex C, should be used, augmented by the data given in **NA.2.33**.

NA.2.4 Imposed loading [BS EN 1993-3-1:2006, 2.3.6(2)]

The following minimum characteristic imposed loads on ladders, platforms and railing should be used.

- a) The ladder, modified bracing, or any component thereof, should be designed to withstand the following simultaneous loads between supports, and should not deflect more than 10 mm or 1/200 of the span, whichever is smaller:
 - 1) 1,5 kN load acting vertically downwards;
 - 2) 0,5 kN point load acting horizontally.

Where critical on a longer ladder run, the loading should be considered to apply at a minimum interval of 5 m.

- b) Platform and walkway flooring should be designed to withstand the following loads simultaneously and should not deflect more than 10 mm or 1/200 of the span, whichever is smaller:
 - 1) 1,5 kN load over a square of 150 mm side acting vertically downwards;
 - 2) 1,5 kN/m² distributed load acting vertically downwards.
- c) Platform and walkway hand railings should be designed to withstand the following loads simultaneously and should not deflect laterally more than 15mm:
 - 1) 1,5 kN point load acting vertically downwards;
 - 2) 0,75 kN point load acting horizontally.
- d) All imposed loads due to access requirements should be deemed to apply with a mean wind speed of 10 m/s and no ice loading.

NA.2.5 Accidental and other actions [BS EN 1993-3-1:2006, 2.3.7]

The possibility of explosions, vandal damage and fire should be considered in design. Guy rupture should be considered for guyed masts of high reliability. Advice is provided in BS EN 1993-3-1:2006, 2.1.1(3)P.

NA.2.6 Actions arising from fitting safety access equipment [BS EN 1993-3-1:2006, 2.3.7(4)]

It is an assumption of this National Annex that a suitable method of safe access, commensurate with the through-life operation and maintenance of the structure, has been considered by the designer and recorded in the maintenance manual. Where this includes the use of designated anchor points [BS EN 795] their location and use should be clearly specified. Where safe access requires the use of anchorage points [BS EN 365] their operation and use should be specified and their effects on the structure considered.

Particular areas that might be unsuitable for use as a fall arrest hard point include:

- handrails;
- redundant bracing;
- some designs of ladder.

NA.2.7 Structures subject to an agreed full-scale testing programme [BS EN 1993-3-1:2006, 2.5(1)]

No additional information is provided.

NA.2.8 Design service life [BS EN 1993-3-1:2006, 2.6(1)]

For the purposes of BS EN 1993-3-1, the service life, T , in years, is taken as the intended period of service of the structure and should be set down in the project specification. A structure designed in accordance with BS EN 1993-3-1 might, if adequately maintained, provide consistent reliability beyond the period of its service life. However, the fatigue life could limit the period of reliable service.

NA.2.9 Allowance for corrosion [BS EN 1993-3-1:2006, 4.1(1)]

No further information is provided.

NA.2.10 Corrosion protection of guys [BS EN 1993-3-1:2006, 4.2(1) Note]

The guidance given in the Note to BS EN 1993-3-1:2006, 4.2(1), should be used.

NA.2.11 Global analysis of masts or guyed chimneys [BS EN 1993-3-1:2006, 5.1(6)]

No further information is deemed necessary for global analysis of masts or guyed chimneys.

NA.2.12 Continuity in triangulated structures [BS EN 1993-3-1:2006, 5.2.4(1)]

No additional information is provided.

NA.2.13 Partial factors on resistance [BS EN 1993-3-1:2006, 6.1(1)]

The following partial factors on resistance should be used:

Resistance of member to yielding	$\gamma_{MO} = 1,00$
Resistance of member to buckling	$\gamma_{M1} = 1,00$
Resistance of net tension at bolt holes	$\gamma_{M2} = 1,25$
Resistance of guys and their terminations	$\gamma_{Mg} = 2,00$
Resistance of insulating material	$\gamma_{Mi} = 2,50$.

The factor γ_{Mg} applies to the guy and its socket (or other termination). The factor γ_{Mi} applies to the ceramic insulating material only. The associated steel pins, linkages and plates are designed for compatibility with the guy and its socket, and might require enhanced values of γ_{MO} and γ_{M2} . Values of $\gamma_{MO} = 1,4$ and $\gamma_{M2} = 1,75$ should be used.

NOTE 1 For structures or elements that are to be type-tested, or where similar configurations have previously been type-tested, the partial factors, γ_{Mr} , may be reduced, subject to the outcome of the testing programme.

NOTE 2 These partial factors for actions and resistance might not be appropriate for the assessment of existing structures. Consideration needs to be given to the design, detailing, fabrication and maintenance of such structures in applying BS EN 1993-3-1 and this National Annex. Such factors need to be agreed between the client, the designer and the competent authority.

NA.2.14 Compression members [BS EN 1993-3-1:2006, 6.3(1)]

Compression members in lattice towers and masts should be designed using the procedure given in BS EN 1993-3-1:2006, Annex G and Annex H.

NA.2.15 Partial factors for connections in towers and masts [BS EN 1993-3-1:2006, 6.4.1(1) Note]

The partial factors for connections recommended in BS EN 1993-1-8:2005, Table 2.1, as modified by the UK National Annex, should be used for towers and masts.

NA.2.16 Flange connections of circular hollow sections [BS EN 1993-3-1:2006, 6.4.2(2)]

NA.2.16.1 The following procedure may be used for the design of flange connections of circular hollow sections.

- a) The relationships between flange thickness, expressed as a ratio of tube wall thickness, bolt prying factor, and extent to which the tube is loaded in tension, are shown in Table NA.1.

For the required tube design tensile strength expressed as a proportion of its maximum tensile capacity, the combination of bolt prying factor along the line in the table and flange thickness ratio above this value should be provided as a minimum.
- b) Divide the tensile design strength of the bolts by the bolt prying factor shown in Table NA.1 to determine the direct tension capacity of the bolt.
- c) The pitch circle diameter of the bolts is to be as small as practicable.
- d) The "edge" distance between the flange edge and pitch circle diameter ought not normally to be less than 1,25 times the bolt diameter.

This procedure is generally applicable to flanges in full contact bearing.

NOTE 1 It might be necessary to increase the minimum thickness to allow for machining to compensate for welding distortion, particularly in the case of blank flanges where a seal or snug fit is required.

NOTE 2 This procedure is not appropriate for tube diameters greater than 200 mm.

NOTE 3 For flanges where direct contact bearing is required, the flatness is to be such that when measured against a straight edge laid against the full length of the bearing surface in any direction:

- over at least 50% of the length, the gap measured does not exceed 0,25 mm;
- over at least 90% of the length, the gap measured does not exceed 0,75 mm.

NA.2.16.2 For the design of flange connections of solid circular members and of tubular members of diameter greater than 200 mm, due account should be taken of the stress pattern under combined axial load, shear and bending, including the effect of prying action. No specific rules are provided and design should be undertaken from first principles, ensuring the general provisions of BS EN 1993 are satisfied.

Table NA.1 Relationships between flange, tube and bolts

Ratio of flange to tube wall thickness ^{A)} for						
Blank flanges 	2,0	1,9	1,8	1,7	1,6	1,5
Ring flanges 	3,0	2,8	2,6	2,4	2,2	2,0
Ratio of tensile design strength required to maximum tensile capacity of tube ^{B)}	Increase in direct tension to allow for prying in the flange bolts (bolts prying factor)					
1,0	1,2	Do not use in shaded zone				
0,9	1,1					
0,8	1,0					
0,7	1,0					
0,6	1,0					
0,5	1,0					

^{A)} Where different grades of steel are used in the tube and flange, the minimum ratio of flange to tube wall thickness should be varied in accordance with the ratio of the square root of their respective yields, within the range shown in the table.

^{B)} The relationship between flange thickness ratio and bolt prying factor is a function of the extent to which the tube is loaded in tension.

NOTE For flanges not in full contact bearing only the hatched zone of Table NA.1 is to be used.

NA.2.17 Mast base joints [BS EN 1993-3-1:2006, 6.5.1(1)]

The recommended procedure to allow for eccentricities at the mast base should be used.

NA.2.18 Partial factors on serviceability and limits [BS EN 1993-3-1:2006, 7.1(1)]

The recommended value of γ_M of 1,0 should be used. The limit of deflection or rotation under the maximum loading from the characteristic wind speed should be as agreed between the designer, the client and the competent authority.

NOTE 1 The client might need to consider the following.

- The duration of exceedance of such limits. Figure NA.1 provides the number of hours per year for which the mean speed is exceeded, expressed as a fraction of the 0,02 annual probability wind speed.
Alternatively, where appropriate records are available the statistical distribution of speeds appropriate to the site may be obtained by analysis of validated wind records obtained in open terrain as near as possible to the site.
- The number of events of such limits.
- Whether steady (ten minute mean) or fluctuating (2–3 second gust) components of wind cause such limits to be critical.