

Specification for

Steel chimneys

UDC 697.84:669.14:006.3.8

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW



Document Sharing Hub

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Civil Engineering and Building Structures Standards Policy Committee (CSB/-) to Technical Committee CSB/21, upon which the following bodies were represented:

- Association of Consulting Engineers
- British Ceramic Research Association
- British Concrete Association
- British Flue and Chimney Manufacturers' Association
- British Precast Concrete Federation Ltd.
- Concrete Society
- Department of the Environment (Property Services Agency)
- Federation of Civil Engineering Contractors
- Institution of Gas Engineers
- Institution of Civil Engineers
- Institution of Structural Engineer
- National Federation of Master Steeplejacks and Lightning Conductor Engineers
- Refractory Contractors' Association

This British Standard, having been prepared under the direction of the Civil Engineering and Building Structures Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 22 December 1989

© BSI 01-1999

First published November 1966
Second edition March 1978
Third edition December 1989

The Following BSI references relate to the work on this standard:
Committee reference CSB/21
Draft for comment 86/11337 DC

ISBN 0 580 17688 6

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 References	1
3 Definitions	1
4 Chimney shells	3
5 Supporting structures	8
6 Chimney linings	9
7 Exterior insulation	11
8 Protective treatments	13
Appendix A Inspection and maintenance	15
Appendix B Wind-excited oscillations	15
Appendix C Recommendations for the use of stainless and other steels	17
Figure 1 — Effective height of chimney shell	18
Figure 2 — Typical example of information plate	19
Table 1 — Temperature coefficient, K_t	5
Table 2 — Corrosion allowances	6
Table 3 — Insulation values	11
Table 4 — Values of K for different types of construction	16
Publications referred to	Inside back cover

Foreword

This new edition of this standard has been prepared under the direction of the Civil Engineering and Building Structures Standards Policy Committee and replaces BS 4076:1978 which is withdrawn.

This edition introduces technical changes to bring the standard up-to-date but it does not reflect a full review of the standard, which will be undertaken in due course.

This edition incorporates Amendment No. 1 to BS 4076:1978 issued in August 1979 and further, previously unpublished, amendments resulting from the 1986 review and public consultation. These further amendments include further updating of wind-excited oscillation considerations, a refinement of external corrosion allowances and the introduction of a fixed information plate.

This standard was first published in 1966. It was revised in 1978 as follows: to include three amendments dealing with the effect of wind on circular chimney shafts in order to maintain the relationship with CP 3:Chapter V-2 "Wind loads"; and because a general revision of the standard was necessary, after the requirements of this standard had been applied and additional experience had been gained in its application during the intervening years. The opportunity was also taken to metricate the standard in accordance with BSI policy.

In the 1978 revision, the clause dealing with corrosion was expanded and the corrosion allowance was amended in the light of experience.

Also in the 1978 revision, in view of the fact that the majority of chimney shafts were by this time welded, it was considered essential that provision be made in this standard to ensure that such welding was carried out in a satisfactory manner. As a result of this development it was more than ever necessary that adequate consideration be given to wind effect upon smooth shafts of this construction. Appendix B was therefore revised and expanded in 1978 to accord with the latest technical information on this very important and controversial subject. Although more research was still needed in this field, it was hoped that the information contained in the appendix would prove of assistance to designers.

It has been assumed in the drafting of this standard that the design of steel chimney shafts will be entrusted to appropriately qualified engineers for whose guidance it has been prepared, and that the work will be executed under the direction of appropriately qualified supervisors.

It cannot be too strongly stressed that it is essential at the enquiry stage that all relevant information be provided so that the contractor has complete and sufficient information. Any special design or site considerations (e.g. foundations, which are not normally designed by a specialist chimney contractor) should be included so that a satisfactory estimate can be given. This will avoid any misunderstandings arising from inadequate information.

Attention is also drawn to the fact that statutory consent may be necessary in certain cases.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This standard relates to the structural design and construction of steel chimneys, with or without linings, and their supports, and to the application of lining or cladding to such chimneys, where required. Recommendations with regard to inspection and maintenance are given in Appendix A. The principles described in this standard apply generally to chimneys varying widely in height, shape, purpose and design. The design of chimneys of other than circular cross section is not included in this standard. Chimneys in pairs, rows or groups, and those near other structures of comparable height, may be subject to exceptional wind force and particularly wind-induced oscillation greater than that allowed for in this standard. Appropriate expert advice should therefore be obtained in these cases.

The purpose for which the chimney is required will determine whether lining, insulation or cladding is necessary.

2 References

The titles of the publications referred to in this standard are listed on the inside back cover.

3 Definitions

For the purposes of this British Standard the following definitions apply.

3.1

access door

a door for the entry of personnel

3.2

access hooks

fittings welded to a chimney to permit the attachment of steeplejack's equipment (see BS 3678)

3.3

aerodynamic stabilizer

a device fitted to the structural shell to reduce wind-excited oscillations by modifying vortex shedding

3.4

base cone

a truncated cone incorporated immediately above the baseplate of a chimney to reduce deflection

3.5

baseplate

a horizontal plate fixed to the base of the chimney

3.6

base gussets

triangular fins of steel fixed to the shell of the chimney and to the baseplate

3.7

base stool

a construction comprising two vertical plates, welded to the chimney shell and to the baseplate, supporting a horizontal plate through which the holding-down bolts pass

3.8

blanking-off plate

an imperforate plate fitted immediately beneath the inlet of a chimney to prevent the waste gases reaching the lower portion of the chimney

3.9

boiler-mounted chimney

a chimney supported by a boiler and its foundation

3.10

bracket

a construction providing resistance to lateral displacement of the chimney, and/or supporting part or all of the weight of the chimney

3.11

bracketed chimney

a chimney in which not all external applied loads (e.g. wind) are carried exclusively by the structural shell and for which brackets are provided to ensure stability

3.12

cap-plate

a sloping plate fitted to the top of the structural shell, covering the area between it and the liners and incorporating cravats through which the liners protrude

3.13

cleaning door

a door, normally at the base of the chimney, to permit the removal of flue dust

3.14

cope band

a steel section attached to the top of the chimney around its perimeter to give added strength and corrosion resistance at this level

3.15

cope hood

a hood fitted externally to the top of a liner, covering the upstand of the cap plate, to prevent the ingress of rain water

**3.16
corrosion test piece**

a fixed or removable steel plate insert, generally of lesser thickness than the shell of the chimney, in contact with the waste gases and fitted at strategic points where maximum corrosion is expected to occur

**3.17
cowl**

a conical or dished cap fitted to the top of the chimney to reduce the ingress of rain water

**3.18
cravat**

an upstand fixed to the roof, roofplate or cap plate to prevent the ingress of rain water

**3.19
doubling plate**

a plate fixed to the shell to reinforce it where increased stresses occur

**3.20
double skin chimney**

a chimney consisting of an outer load-bearing shell and an inner steel liner which carries the flue gases

**3.21
guy**

a wire rope attached at one end to a chimney and anchored at the other so as to provide tensile resistance to the lateral displacement of the chimney

**3.22
guy band**

a steel section fitted around the outside of a chimney with provision for the attachment of guys

**3.23
guyed chimneys**

a chimney in which not all externally applied loads (e.g. wind) are carried exclusively by the structural shell and for which guys are provided to ensure stability

**3.24
holding-down bolts**

bolts built into a concrete foundation, brick base or supporting framework to provide anchorage at the base of the chimney

**3.25
inlet**

a short duct fixed to the shell or baseplate of a chimney for the entry of flue gases

**3.26
intermediate cone**

a truncated cone incorporated in the chimney shell at an intermediate level to reduce deflection

**3.27
jointing flange**

a steel section fitted to the end of a chimney section to enable sections to be connected together

**3.28
lateral supports**

supports positioned at appropriate levels within the structural shell to locate the liners and to allow for their independent expansion

**3.29
liners**

ducts contained within a structural shell

**3.30
liner base**

a suitable support positioned at a convenient height above the baseplate of the structural steel shell to carry the weight of the liners

**3.31
lining**

a material applied to the internal face of the chimney to prevent the fuel gases impinging upon the steel shell

**3.32
multi-flue chimney**

a group of two or more chimneys within a structural framework or a group of two or more liners within a structural shell

**3.33
roofplate**

a plate which follows the contour of the roof round the chimney where it passes through the roof

**3.34
self-supporting chimney**

a chimney in which externally applied loads (e.g. wind) are carried exclusively by the structural shell and which, together with the foundation, will remain stable under all design conditions without additional support

**3.35
stay**

a rigid member providing both tensile and compressive resistance to the lateral displacement of the chimney

3.36**stayed chimney**

a chimney in which not all externally applied loads (e.g. wind) are carried exclusively by the structural shell and for which stays are provided to ensure stability

3.37**strake (vane)**

an aerodynamic stabilizer fitted to reduce wind-excited oscillations

3.38**structural shell**

the main external structure of the chimney, excluding any flanges

3.39**top cone**

a truncated cone or other device fitted at the top of a chimney to increase the gas exit velocity, in order to minimize cold air inversion (see 7.1)

NOTE It is sometimes incorrectly referred to as a venturi.

3.40**tundish**

a conical or sloping blanking-off plate provided with facilities for drainage

3.41**weatherhood**

a hood designed to shed rain water clear of the cravat and prevent its entry into the building

4 Chimney shells**4.1 Loading**

The determination of dead load, wind load and other loads shall be in accordance with the recommendations of BS 6399-1 and CP 3:Chapter V-2, and subject to the following provisos.

a) *Force coefficient.* The force coefficient for a circular chimney of smooth construction, i.e. with no external ribs or plate projections exceeding 1/150 of the diameter, other than horizontal ones, shall be taken as 0.6.

Wind force on ladders constructed in accordance with BS 4211 fixed to a chimney shall be determined in accordance with the recommendations of CP 3:Chapter V-2 and added to the force on the chimney calculated in accordance with the requirements of this standard.

b) *Factor S_3 .* The factor S_3 in CP 3:Chapter V-2:1972 shall be taken as not less than 1.0.

c) *Factor S_2 .* For chimneys over 80 m in height, the factor S_2 shall be taken from the class C column. For those chimneys between 10 m and 80 m the class C factor shall be increased by the difference between class B and class C at the appropriate level, multiplied by 80 minus the chimney height, and divided by 70,

$$\text{i.e. add } \frac{(B_H - C_H)(80 - h)}{70}$$

where

B_H is the factor for class B at the appropriate level above ground;

C_H is the factor for class C at the appropriate level above ground;

h is the actual height of chimney (in m) For chimneys less than 10 m high the values in the class B column shall be used.

d) *Oscillation.* To prevent across-wind oscillations the stability of the chimney should be checked against the criteria of Appendix B. If these criteria are exceeded, perform one of the following.

1) Provide an aerodynamic stabilizer. It is recommended that helical strakes or guys are used. Strakes should have three rails, projecting between 0.1 and 0.12 times the diameter of the chimney, wound, equally spaced, around the perimeter of the shell at a pitch of about five times the diameter of the chimney. The strakes should extend for the upper third of the chimney height. The drag force coefficient shall be calculated over the projected area of circular cross section enclosing the stabilizer ribs. This coefficient shall be taken as 1.2.

2) Provide additional structural damping to ensure that the stability criteria of Appendix B are met. This can be provided by tuned mass or impact dampers or by resilient materials at the main supports.

NOTE Oscillation of guyed, stayed, bracketed, pairs or groups of stacks is outside the scope of this standard. However, guys, stays or brackets should be adequate to eliminate appreciable increase of stress due to movement.

4.2 Materials

4.2.1 Plates and sections

Steel plates used in the construction of chimneys coming within the scope of this British Standard shall comply with the requirements for grade 43A of BS 4360:1986. Alternatively, steels other than grade 43A, or suitable stainless or alloy steels may be used in special circumstances (see Appendix C) but the thicknesses shall otherwise comply with the requirements of this specification. Supporting steelwork and ancillary fittings shall comply with the requirements of BS 4 or BS 4848 for dimensions and with not less than grade 43A in BS 4360:1986 for quality.

4.2.2 Bolts and nuts

4.2.2.1 Carbon steel

All carbon steel bolts and nuts shall have a tensile strength of not less than 400 N/mm^2 and a minimum elongation of 17 %, as defined in BS 4190:1967 and BS 4395-1:1969.

4.2.2.2 High tensile steel : structural quality

The material used for the manufacture of high tensile steel bolts, nuts and washers, for which permissible stresses are given in BS 449, shall have a minimum tensile strength of 580 N/mm^2 and other mechanical properties appropriate to grade 50B of BS 4360:1986.

4.2.2.3 Friction grip bolts

Friction grip bolts, nuts and washers shall comply with the requirements of BS 4395-1, and shall be used in accordance with the requirements of BS 4604-1.

4.2.3 Guy ropes and fittings

Guy ropes shall comply with the requirements of BS 302-3. Fittings for guys shall be galvanized and shall comply with the requirements of the relevant British Standards (e.g. BS 462, BS 463, BS 464, BS 3032, BS 3551 and BS 5281). Guy ropes with hemp cores shall not be used.

4.2.4 Access fittings

Access fittings shall comply with the requirements of BS 3678. The attachment of permanent ladders to steel chimneys is not recommended but, if required, they shall comply with the requirements of BS 4211.

4.3 Design and construction

4.3.1 General

The use of structural steel for the shell and other components of steel chimneys shall be in accordance with the requirements of the relevant clauses of BS 449.

The recommendations in BS 449 regarding the following matters shall, however, be superseded by the requirements of this standard:

- a) minimum thickness;
- b) allowable deflection;
- c) allowable compressive stress in circular shells due to direct force and bending moment;
- d) allowance for corrosion;
- e) allowance for temperature;
- f) stresses due to wind.

All members, including guys, if any, shall be taken into account in design calculations, except that the weight of the flue lining shall be included in the dead load, but its strength shall be excluded from the calculations for bending and stiffness.

4.3.2 Minimum thickness of steel

4.3.2.1 Chimney shell

The minimum thickness of the structural shell, in single or multiple shell constructions, shall be the calculated thickness obtained from stress and deflection considerations plus the corrosion allowance (see 4.3.4.5), but shall not be less than 6.0 mm, nor less than 1/500 of the outside diameter of the chimney at the same height. Owalling shall be considered, see B.4.

4.3.2.2 Chimney liner

The minimum thickness of the steel liner in a double skin or multi-flue construction shall be the calculated thickness obtained from stress considerations plus the corrosion allowance, but shall be not less than 6.0 mm.

NOTE Plastic liners are not covered by this standard.

4.3.2.3 Supporting steelwork

The minimum thickness for hot rolled sections used for external construction exposed to the weather shall be 8.0 mm, and for constructions not so exposed and ancillary steelwork, 6.0 mm (see BS 449). These provisions do not apply to the webs of British Standard (see 4.2.1) rolled steel sections, or to packings.

The minimum thickness of British Standard (see 4.2.1) hollow sections sealed at the ends, used for external construction exposed to the weather or other corrosive influences shall be 4.0 mm, and for constructions not so exposed, 3.0 mm.

4.3.2.4 Flanges

The minimum thickness of jointing flanges shall be 6.0 mm.