

## Chimneys and Flues

A chimney is a building as defined in the Buildings Ordinance. Chimneys and flues should not only be structurally stable but also be protected from corrosion.

### Structural Design

2. For the structural design of a chimney, special attention should be given to the following points :

(a) **Wind load**

Provision for wind-excited oscillations should be given and analyzed by aerodynamic methods. For circular chimneys the simplified method in Appendix A may be adopted.

(b) **Steel chimneys**

(i) Design should be in accordance with the appropriate provisions in the Code of Practice for the Structural Use of Steel with the modifications given in BS 4076:1989.

(ii) To control buckling, the allowable compressive stress in the chimney structure should be taken as 115 MPa in the case of a chimney with effective height to diameter ratio of less than 21 and diameter to thickness ratio of less than 130; it should be further reduced for higher aspect ratios.

The 25% increase in allowable stresses due to wind load should not be applied to the design of the chimney.

(iii) Reduction coefficient should be applied to the allowable stresses in steel where the temperature is higher than 315°C.

(iv) Guys ropes provided as anchorage to a chimney should be positioned at a minimum distance of 3 m below the outlet of the chimney to avoid the corrosion action of the emergent combustion products.

In view of the practical problems associated with examination and maintenance, the guy ropes should not be considered in strength and stability calculations.

- (v) Brackets constructed to provide resistance to lateral displacement of the chimney and/or supporting part or all of the weight of the chimney should be positioned at distances not exceeding 6 m apart. Materials, design and construction of the brackets should comply with the appropriate provisions of the Building (Construction) Regulations.

### **Construction and Corrosion Protection**

3. For construction and corrosion protection of chimneys and flues, the relevant parts of BS 4076:1989, BS 4543:Part 2 and Part 3:1990 and BS 5854:1980 should be followed. Attention should also be given to the following points :

(a) **Height of chimney and flue**

A chimney or flue should terminate in such a position that the products of combustion cannot enter nearby windows or other openings, fresh air inlets, mechanical ventilation inlets or exhausts. The disposition is considered satisfactory if its height is approved by the Director of Environmental Protection under the Air Pollution Control Ordinance, Cap. 311, subject to a minimum of 3 m above the highest point of its own roof or of any adjoining structure, whichever is the higher.

(b) **Heat transmission**

A chimney or flue should be so placed and shielded as to be accessible by maintenance personnel only. It should also be so placed, shielded and as necessary insulated that the temperature of the exposed faces would not cause danger to any person or any part of any building.

The acceptable temperature is different in each case according to the materials of the nearby parts of any building and the use of the surrounding areas. The insulation required depends on the acceptable temperature and the type and rate of fuel used. It is impossible to specify common standards.

Calculations and justification should therefore be provided in each case to verify compliance with the Building (Construction) Regulations. In this connection, BS 5854:1980 provides some guidelines.

(c) **Corrosion protection**

Both the exterior and interior surfaces of a steel chimney or flue should have satisfactory protective treatment in accordance with BS 4076:1989. Allowance for corrosion should be made in the shell in addition to the thickness obtained from calculations for structural stability. Normally, allowance of 3 mm would be required for chimneys externally fitted with waterproof insulation or cladding and internally lined and protected. For unprotected chimneys, 4.5 mm should be provided for a design life of ten years and 8 mm for 20 years. Unprotected oil-fired steel chimneys are not recommended.

(d) **Bimetallic action**

Bimetallic action could adversely affect a chimney or flue, and should be avoided. If it is essential in the design that two dissimilar metals have to be connected, a suitable non-conductive and water-impervious film or agent should be placed between them.

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### Wind-excited Oscillations of Circular Chimneys

Flexible slender structures are subject to oscillations due to wind action. It has been found that chimneys of circular cross section oscillate more strongly across wind than along wind. It is therefore reasonable to assume that the along wind oscillation will not cause stresses greater than those calculated for the forces in the 1983 edition of the Code of Practice on Wind Effects. For across wind oscillation, the following simplified approach adapted from BS 4076:1989 may be applied :

- (a) The Strouhal critical velocity  $V_{cr}$  for the chimney is to be determined by :-

$$V_{cr} = 5D_t f$$

where  $f$  is the natural frequency of the chimney on its foundations (in Hz), to be calculated analytically or by the following approximate formula in case of a regular cone :-

$$f = \frac{500 (3D_b - D_t) \left[ \frac{W_s}{W} \right]^{1/2}}{h^2}$$

and  $h$  is the height of chimney (in m)

$D_t$  is the diameter at top (in m)

$D_b$  is the diameter at bottom (in m)

$W$  is the mass per meter height at top of structural shell including lining or encasing, if any (in kg)

$W_s$  is the mass per meter height at top of structural shell excluding lining (in kg)

- (b) If  $V_{cr}$  exceeds the design wind velocity given by equation (4) in the 1983 edition of the Code of Practice on Wind Effects, severe oscillation is unlikely and no further calculation is required.

/(c) If  $V_{cr}$  ....

- (c) If  $V_{cr}$  is less than the design wind velocity, the tendency to oscillate  $C$  may be estimated by the following empirical formula :-

$$C = 0.6 + K \left[ \frac{10D_t^2}{W} + \frac{1.5 \Delta}{D_t} \right]$$

where  $\Delta$  is the calculated deflection (in m) at the top of the chimney for unit distributed load of 1 kPa

$K$  is 3.5 for all welded construction, 3.0 for welded with flanged and bolted joints and 2.5 for bolted riveted or all riveted.

- (d) If  $C$  is less than 1, severe oscillation is unlikely. If  $C$  is between 1 and 1.3 the design wind pressure for the chimney should be increased by a factor  $C^2$ . If  $C$  is above 1.3 the fitting of stabilizers or dampers should be provided to control oscillations.