

Code of practice for

Assessing exposure of walls to wind-driven rain

Code de bonne pratique pour l'évaluation de
l'exposition des murs à la pluie chassée par le
vent

Bestimmung der Beanspruchung von Wänden
durch Schlagregen

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Committees responsible for this British Standard

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 Association of Consulting Engineers
 Autoclaved Aerated Concrete Products Association
 Brick Development Association
 British Cement Association
 British Ceramic Research Ltd.
 British Precast Concrete Federation Ltd.
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 Calcium Silicate Brick Association Limited
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 Incorporated Association of Architects and Surveyors
 Institution of Civil Engineers
 Institution of Structural Engineers
 National Cavity Insulation Association
 National House-building Council
 Royal Institute of British Architects
 Society of Chief Architects of Local Authorities

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Aggregate Concrete Block Association
 Concrete Brick Manufacturers' Association
 Eurisol (UK Mineral Wool Association)
 Institution of Clerks of Works of Great Britain Inc.
 Loss Prevention Council
 Mortar Producers' Association Limited
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 Royal Institution of Chartered Surveyors

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Foreword

This British Standard has been prepared under the direction of the Civil Engineering and Building Structures Standards Policy Committee. It supersedes DD 93 : 1984 which is withdrawn.

During the revision of CP 121 : Part 1, which resulted in BS 5628 : Part 3, the technical committee recognized the need to develop a method of assessing exposure to wind-driven rain which could be applied to many aspects of the design of masonry.

New data made available by the Meteorological Office made it possible to develop more accurate methods of assessment of local wind-driven rain than were available before. A comparison with the earlier method described in BS 5618 has revealed some significant regional variations.

It became apparent that there are two distinct aspects of exposure to wind-driven rain, as follows:

- (a) average moisture content of masonry, for which the local annual index is the most significant factor;
- (b) rain penetration through the masonry, for which the local spell index is the most significant factor.

It should be emphasized that neither index is precise enough to enable fine distinctions between degrees of exposure to be made. Hence the user should always take account of local knowledge and experience.

Since the publication of DD 93, further work has included:

- (1) research into the relation between local building environments and instances of rain penetration;
- (2) research into the effect of local environment and of building size and design features on rainfall actually falling on walls in buildings.

This further work has led to suggestions for a number of modifications to DD 93. Basic meteorological data remain largely unchanged except that the Channel Islands have now been added to the maps (appendix B). Factors to modify rainfall according to local conditions are now based on empirically determined data from experimental sites rather than solely on wind speed data as previously. In addition, factors to allow for building shape and size have been introduced, also based on data from experimental sites.

Future work will include:

- (i) regular reviews of climatic data to take into account long term climatic changes;
- (ii) research into the relation between exposure and the properties of individual materials, such as absorptive capacity, and the effects of evaporation and moisture content.

This code of practice represents a standard of good practice and therefore takes the form of recommendations.

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

Code of practice

0 Introduction

The quantity of rain falling on a vertical surface, such as a wall, at any point depends on both the intensity of the rainfall and the wind speed. The Building Research Establishment Report *Driving Rain Index* (1976) postulated that the quantity of rain falling on a vertical surface was proportional to the rate falling on a horizontal surface and to the local wind speed, and incorporated maps of an annual wind-driven rain index, which is the product of the annual average 'airfield' wind speed and annual average rainfall on the horizontal. Appropriate correction factors were given to compute the local value. (One version of this method, which expresses the index as a logarithmic value, is described in BS 5618.)

More recently the Meteorological Office has produced improved values, based on the fact that prolonged rainfall is usually associated with stronger than average winds. New maps for the 'airfield' annual wind-driven rain index have been prepared by summing the hourly products of wind speed and rainfall during the 33 year period 1959 to 1991. These data form the basis for the method of prediction of quantities of rainfall on vertical surfaces, which is described in this code of practice.

Features of this code of practice are that it allows calculations of driving rainfall for different orientations, it allows annual average values to be calculated as well as quantities for the worst likely spell in any 3 year period and it allows corrections to be made for ground terrain, topography, local shelter, and the constructional characteristics of the building concerned.

Site investigations have given information not only on the appropriate choice of modifying factors but also on the reproducibility and accuracy of rainfall data calculated for a given building. This is reflected in the degree of precision with which factors R , T , O and W are given in this code. Any extra precision which would be achieved by a closer definition of the building/site description would not be sufficient to justify the much increased complexity that this would lend to the code.

Appendix A gives worked examples using the wind-driven rain maps in appendix B and the topography factors in appendix C. Further details of the background to this code are given in appendix D.

1 Scope

This British Standard gives recommendations for two methods for assessing exposure of walls in buildings to wind-driven rain, namely the local spell index method and the local annual index method.

It should be noted that this code is not appropriate in respect of the weathertightness of components such as windows. However, the performance of such components can be influenced by the design of the surrounding structure and appendix E may be helpful in this respect.

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover. Other references will be found throughout the text, indicated by bracketed numbers thus [1], and these are listed in the bibliography in appendix F.

2 Definitions

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

2.1 spell

A period, or sequence of periods, of wind-driven rain on a vertical surface of given orientation. A spell is of variable length and can include several periods of wind-driven rain interspersed with periods of up to 96 h without appreciable wind-driven rain (see also appendix D).

2.2 airfield index

The quantity of driving rain that would occur 10 m above ground level in the middle of an airfield, at the geographical location of the proposed wall.

2.3 airfield annual index, D_A

The average annual airfield index for a given direction, in litres per square metre per year.

2.4 airfield spell index, D_S

The airfield index for a given direction during the worst spell likely to occur in any 3 year period, in litres per square metre per spell.

2.5 wall annual index, D_{WA}

The quantity of wind-driven rain in litres per square metre per year at a point on a given wall, based on the airfield annual index and corrections for roughness, topography, obstruction and wall factors.

2.6 wall spell index, D_{ws}

The quantity of wind-driven rain in litres per square metre per spell at a point on a given wall, based on the airfield spell index and corrections for roughness, topography, obstruction and wall factors.

2.7 line of sight

The horizontal view away from the proposed wall, over a sector spanning about 25° either side of the normal to the wall.

2.8 terrain roughness category

A description of the general terrain upwind in terms of the average height and spacing of protective features, e.g. buildings, trees, hedges.

2.9 terrain roughness factor, R

A factor which allows for the general conditioning of the wind speed by the roughness of the terrain upwind of a wall.

2.10 topography factor, T

A factor which allows for the effect of local topography on wind speed.

2.11 obstruction factor, O

A factor which relates to shelter from the very local environment, and allows for obstructions, such as buildings, fences or trees, close to and upwind of the wall. It is also concerned with line of sight.

2.12 wall factor, W

A factor which allows for the characteristics of the proposed wall. It is the ratio between the quantity of water falling on the wall and the quantity falling in equivalent unobstructed space.

NOTE. It is equivalent to the 'catch ratio', a more usual term in related literature.

3 Choice of methods

The local spell index method for assessing exposure to wind-driven rain is a measure of the occurrence of periods of rain, lasting for several hours or even days, whilst the local annual index method for assessing exposure to wind-driven rain is a measure of the total quantity in a year.

The local spell index method should be used when assessing the resistance of a wall to water penetration.

The local annual index method should be used when considering the average moisture content of exposed building material or when assessing the likely growth of mosses and lichens.

4 General

The procedure for the two methods (see clause 3) is essentially the same, as shown on the typical worksheet in figure 1. There are six steps, as follows.

- In each case the first step is to determine the airfield index (see 2.2), using the wind-driven rain maps and the appropriate roses given in appendix B in conjunction with table 1 or 2. The maps show variations in wind-driven rain over distances greater than 1 km whilst the roses show the variation according to the orientation of the proposed wall.
- Assess the effect on wind speed of the general terrain upwind of the proposed wall in terms of the terrain roughness factor R .
- Assess the effect of topography (steeper than 1 in 20 upwind of the wall) in terms of the topography factor T .
- Assess the localized effects of nearby obstructions, giving close shelter to the wall, in terms of the obstruction factor O . (This relies on the concept of line of sight.)
- Assess the effect of the characteristics of the proposed wall (shape, height, overhangs, etc.), in terms of the wall factor W .
- Combine the airfield index (annual or spell) with factors R , T , O , and W to give the annual or spell wall indices as follows:

$$D_{WA} = D_A \times R \times T \times O \times W$$

$$D_{WS} = D_S \times R \times T \times O \times W$$

5 Procedure

5.1 Basic data

The following information is needed for assessment of the local wind-driven rain index:

- geographical location of proposed wall (national grid reference);
- orientation of proposed wall, i.e. the direction the wall faces;
- description of the general terrain upwind of the proposed wall, including any marked changes in ground level within 1 km upwind caused by hills, cliffs, etc.;
- description of any obstructions close to the proposed wall, e.g. neighbouring buildings or trees, including description of any clear line of sight between and beyond closest obstructions;
- description of characteristics of proposed wall, e.g. gable wall, eaves wall, overhangs present, storey height and breadth of wall.

5.2 Step by step procedure

NOTE. Some worked examples are given in appendix A.

5.2.1 Look at the appropriate wind-driven rain map in appendix B. Find the subregion in which the site is located (indicated by the code adjacent to the symbol ○). Where the site lies on a boundary between two subregions, the calculation should be made for both subregions and the highest figure taken.

Find the geographical increment, i , for the site of the proposed wall. These increments are shown between contour lines; if the site lies on a contour line, the larger increment should be used. Increments may be positive or negative. Values of i are shown on the maps in steps of 1 up to 6 and in steps of 2 above 6.

5.2.2 Examine the rose for the particular subregion and method (local annual index or local spell index). Each rose gives 12 values corresponding to different orientations. Select the rose value, r , nearest to the orientation of the proposed wall. In case of doubt, take the highest of the rose values for the two possible wall orientations.

5.2.3 Add the rose value to the geographical increment to obtain the map value m .

$$m_A = r_A + i, \text{ or}$$

$$m_S = r_S + i$$

NOTE. In crossing a subregion boundary either r or i or both may change. (See 5.2.1.)

5.2.4 Obtain the airfield index, D_A or D_S , corresponding to the map value from table 1 or 2.

NOTE. The difference in magnitude between airfield annual and spell indices for a given map value reflects the different parameters being assessed (see clause 3).

5.2.5 Assess the character of the general terrain upwind of the proposed wall, using the descriptions given in table 3, to obtain a terrain roughness factor R . In case of doubt as to which of the two adjacent terrain roughness categories is appropriate then select the one giving the highest value of R .

5.2.6 The wind-driven rain indices given in appendix B take account of the general level of the site above sea level. They do not allow for local topographical features such as hills, cliffs or escarpments which can affect the wind speed in their vicinity.

Hence, consider whether the ground facing the proposed wall slopes away with an average slope of more than 1 in 20 within 1 km of the wall. If it does, use appendix C to calculate topography factor T . If the slope is less than 1 in 20, use table 4 to assess whether other local circumstances have an influence on the speed of wind approaching the wall.

5.2.7 Assess the exposure of the proposed wall in terms of the nearest obstructions. This can vary markedly between buildings depending upon their proximity to other buildings, trees, roads, open spaces such as parks and playing fields, land which slopes downwards from the front of the exposed wall and the edge of a built-up area. Likely changes in the degree of exposure, particularly any arising from any impending development, e.g. the felling of trees, should be taken into account.

Obtain a value for the obstruction factor O . This relies on the line of sight from the proposed wall. If the horizontal view is obstructed, for example by walls or other buildings of similar dimensions to the proposed wall, then the obstruction factors shown in table 5 should be used for that direction (see figure 3). If the view is unobstructed then the obstruction factor is 1.0.

NOTE 1. If there are other buildings nearby but there is an unobstructed horizontal line of sight, for example over their roofs, then the obstruction factor is 1.0 (see figure 3).

NOTE 2. Some buildings within estates have a clear line of sight down open roads. These roads can funnel wind-driven rain even for wind directions not precisely down the road. The wall should be conservatively estimated to have an obstruction factor of 1.0.

NOTE 3. For long walls it may be necessary to make separate assessments for different parts of the wall.

NOTE 4. In practical circumstances it is often necessary to consider obstructions and lines of sight in aggregate. For example, for most suburban sites of two storey housing on flat ground with typical spacing and disposition of blocks, a value of 0.5 can be assumed for houses within the site, provided there are no roads leading away from the proposed wall to open country. Other more detailed examples are given in appendix A.

5.2.8 The amount of rain incident on a wall depends on the type of wall (e.g. gable or eaves), on its height, and on other features such as overhangs or string courses. In addition, the distribution of rainfall intensity varies significantly from one part of a wall to another (for background see appendices D and E).

Obtain the wall factor W for the required position on the wall from table 6.

5.2.9 Calculate the wall annual index, D_{WA} , in l/m^2 per year, using the following equation:

$$D_{WA} = D_A \times R \times T \times O \times W$$

5.2.10 Calculate the wall spell index, D_{WS} , in l/m^2 per spell, using the following equation:

$$D_{WS} = D_S \times R \times T \times O \times W$$

5.2.11 The wall indices D_{WA} , D_{WS} give the quantity of rain falling on the chosen location on the wall.

In some cases, where the wall is non-absorbent or where it may have become saturated, the quantity of run off at a lower level may be required. This can be calculated by taking the average wall factor above that level, using this average value to determine the wall index, and then multiplying this index by the height of the wall above the level concerned. An example is given in appendix A.

Location:
Grid reference:
Orientation:
Map subregion:

	Spell index	Annual index
Geographical increment	<i>i</i>	
Rose value	<i>r</i>	
Map value (<i>i</i> + <i>r</i>)	<i>m</i>	
Airfield indices (table 1 or 2)	$D_S =$ l/m ² per spell	$D_A =$ l/m ² per year
Terrain roughness factor (table 3)	<i>R</i>	
Topography factor (table 4)	<i>T</i>	
Obstruction factor (table 5)	<i>O</i>	
Wall factor (table 6)	<i>W</i>	
Wall indices for the appropriate direction of wall	$D_{WS} =$ l/m ² per spell	$D_{WA} =$ l/m ² per year

Figure 1. Typical worksheet for wind-driven rain calculations

Table 1. Airfield spell indices	
Spell map value, m_s	Airfield spell index, D_s
	l/m ² per spell
0	6.3
1	7.1
2	7.9
3	8.9
4	10.0
5	11.2
6	12.6
7	14.1
8	15.9
9	17.8
10	20.0
11	22.4
12	25.2
13	28.3
14	31.7
15	35.6
16	40.0
17	44.9
18	50.4
19	56.6
20	63.5
21	71.3
22	80.0
23	89.8
24	101.0
25	113.0
26	127.0
27	143.0
28	160.0
29	180.0
30	202.0
31	226.0
32	254.0
33	285.0
34	320.0
35	360.0
36	404.0
37	452.0
38	508.0
39	570.0
40	640.0
NOTE 1. 1 l/m ² = 1 mm of rain.	
NOTE 2. Values in the table have been calculated using the following formula:	
$m_s = 10 + 19.93 \log_{10} (D_s/20).$	

Table 2. Airfield annual indices	
Annual map value, m_A	Airfield spell index, D_A
	l/m ² per year
0	100
1	110
2	125
3	140
4	160
5	180
6	200
7	225
8	250
9	285
10	315
11	355
12	400
13	450
14	505
15	565
16	635
17	715
18	800
19	900
20	1010
21	1130
22	1270
23	1425
24	1600
25	1795
26	2015
27	2265
28	2540
29	2850
30	3200
31	3590
32	4030
33	4525
34	5080
35	5700
36	6400
37	7185
38	8065
39	9050
40	10160
NOTE 1. 1 l/m ² = 1 mm of rain.	
NOTE 2. Values in the table have been calculated using the following formula:	
$m_A = 6 + 19.93 \log_{10} (D_A/200).$	

Table 3. Terrain roughness factor R

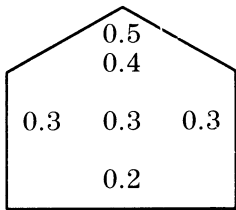
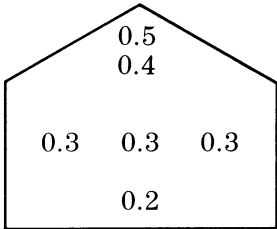
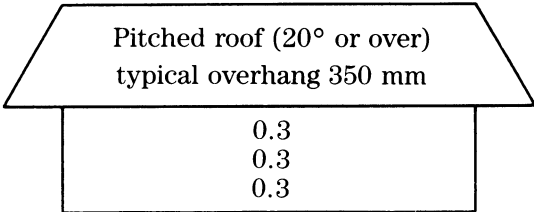
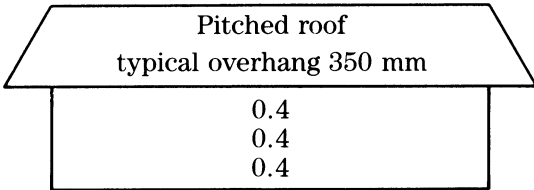
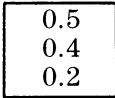
Terrain roughness category	Description of the terrain upwind of (i.e. facing) proposed wall	Terrain roughness factor R
0	Land offering no effective shelter to the wall, which is less than 8 km from a coast or large estuary. See figure 2(a)	1.15
1	Land offering no effective shelter to the wall, which is 8 km or more from a coast or large estuary. Examples are open country with walls or hedges more than 200 m apart and land that falls away in the direction upwind of the wall if this means that buildings or trees offer little protection. See figure 2(b)	1.00
2	Land with frequent low-level obstructions such as walls, hedges or single storey buildings. Examples are farmland and low-density housing development especially those with a large proportion of single storey buildings. See figure 2(c)	0.85
3	Land with closely spaced obstructions, such as buildings and trees. Examples are built-up areas, well-wooded parkland and forests. The obstructions should offer a substantial degree of wind shelter. See figure 2(d)	0.75

Table 4. Values of topography factor T , for land that does not slope down steeper than 1 in 20

Description	Topography	Remarks
Valley or grouping of buildings liable to produce a funnelling of the wind	1.2	
Steep-side, enclosed valleys known to be sheltered from the wind	0.8	Such cases are rare
All other cases (where nearby slopes are less than 1 in 20)	1.0	For effects of slopes steeper than 1 in 20 see appendix C

Table 5. Obstruction factor O (see also figure 3)

Distance of obstruction from proposed wall	Obstruction factor O
m	
> 4 to 8	0.2
> 8 to 15	0.3
> 15 to 25	0.4
> 25 to 40	0.5
> 40 to 60	0.6
> 60 to 80	0.7
> 80 to 100	0.8
> 100 to 120	0.9
> 120	1.0

Table 6. Wall factor <i>W</i>		
Description of wall	Average value	Distribution
two storey gable	0.4	
three storey gable	0.3	
¹⁾ multi-storey (flat roof)	0.2 for e.g. ten storey (but note higher intensity at top)	0.5 for top 2.5 m 0.2 for remainder
two storey eaves wall	0.3	
three storey eaves wall	0.4	
two storey flat roof (pitch < 20°)	0.4	

¹⁾ These data apply to multi-storey blocks of normal aspect width. No data are available for exceptionally narrow buildings.



(a) Category 0



(b) Category 1

Figure 2. Terrain roughness categories (photographs reprinted by kind permission of Aerofilms Limited)

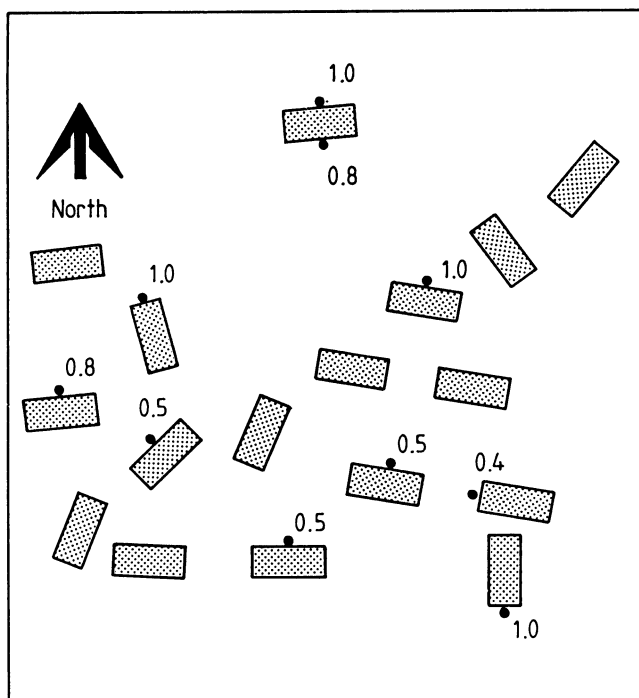


(c) Category 2



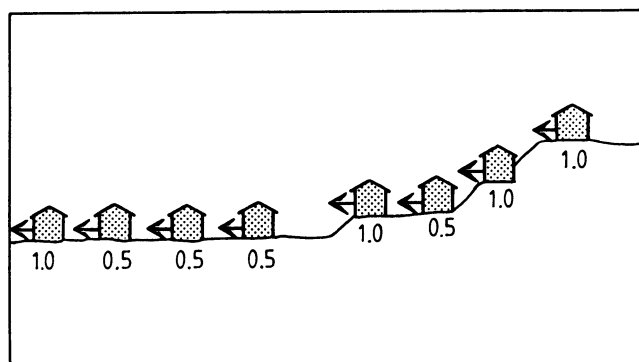
(d) Category 3

Figure 2. Terrain roughness categories (concluded) (photographs reprinted by kind permission of Aerofilms Limited)

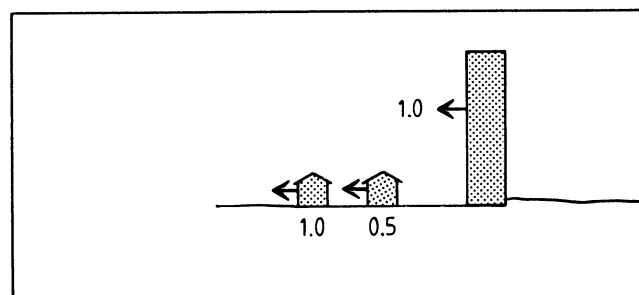


(a) Plan view

NOTE. Obstruction factors relate to a person standing at the marked points with their back to the wall and viewing a field of 25° each side to the normal to the wall.



(b) Effect of topography on line of site and hence obstruction factor



(c) Effect of building height on line of sight and hence obstruction factor

Figure 3. Obstruction factor expressing local shelter to a wall (see also table 5)

Appendices

Appendix A. Worked examples

A.1 Map values

A.1.1 General

In each of the examples given in A.1.2 to A.1.4, map values are calculated for a south facing wall.

A.1.2 Centre of subregion

Consider Brighton on map 3.

The subregion is PH1 (see 5.2.1). The spell and annual rose values are $r_S = 26$ and $r_A = 15$ (see 5.2.2). The geographical increment, $i = +1$ (see 5.2.1). Hence the spell and annual map values are $m_S = 27$ and $m_A = 16$ (see 5.2.3).

A.1.3 Boundary between two subregions

Consider a place at grid reference ²790 ⁶880 (south of Stirling) on map 12.

Calculate the map values for both subregions as follows:

subregion	ED3	ED7
geographical increment i	+5	+5
spell rose value r_S	18	20
spell map value m_S	23	25

The higher map value of 25 should be used (see 5.2.1).

NOTE. The geographical increment is the same on both sides of the boundary (compare with A.1.4).

A.1.4 Meeting point of four boundaries

Consider a place at grid reference ⁴620 ¹765, just west of Pangbourne (see maps 2, 3 and 5).

Calculate the map value for all four subregions, as follows:

subregion	HW1	LN1	OX1	SY7
geographical increment i	+1	+1	+1	-2
spell rose value r_S	21	21	21	25
spell map value m_S	22	22	22	23

The higher map value of 23 should be used (see 5.2.1).

NOTE. Both the geographical increments and the rose values vary when crossing one boundary (compare with A.1.3).

A.2 Local variations in protection

A.2.1 To illustrate values for obstruction factor O , figure A.1 ((a) to (e)) shows typical views or lines of sight from walls whose exposure may be required as follows. (All views are from two storey walls.)

A.2.2 Consider the housing estate shown in figure A.2, on the southern edge of a town and close to open country. The various factors for the south-facing walls of three houses are given in table A.1.

Table A.1. Factors R , T , O , W for example walls					
House	Description	R	T	O	W
A	two storey eaves wall on edge of estate, facing open country	1.0	1.0	1.0	0.3
B	two storey eaves wall, 15 m behind house A	1.0	1.0	0.3	0.3
C	two storey gable wall with clear line of site down road to open country	1.0	1.0	1.0	0.4

House A is on the edge of the estate, with a terrain roughness category 1 (factor 1.0 from table 3) and there are no obstructions to the south, so the obstruction factor is also 1.0 (see table 5). House B is protected by the houses on the south, so whilst the general terrain roughness category is still 1, the obstruction factor is 0.3 (see table 5). House C has an open aspect to the south to the nearby countryside, so the obstruction factor is 1.0 (see table 5). In each case, the site is fairly level and the topography factor is 1.0 (see table 4).

A.3 Effect of orientation of wall

Consider the north-facing and south-facing eaves walls of a three storey building on the sea front at Hove, Sussex at national grid reference 5290E 1044N (see map 3).

Looking from the building in a northerly direction, there are many buildings of similar height, the nearest being 50 m away. Thus the terrain roughness category is 3 and the roughness factor is 0.75 (see table 3). Looking from the building in a southerly direction, only the sea can be seen. Thus the terrain roughness category is 0 and the roughness factor is 1.15 (see table 3).

To the north and south of the site the ground is fairly level, so the topography factor for both directions is 1.0 (see table 4).

The obstruction factor for the north-facing wall is 0.6, since the distance of the nearest obstruction lies in the range 40 m to 60 m, and for the south-facing wall the factor is 1.0, since there are no obstructions (see table 5). The average wall factor for a three storey eaves wall is 0.4 (see table 6). The wall indices D_{WA} and D_{WS} for these two walls can now be calculated, as shown on the worksheet in figure A.3.

A.4 Effect of change of local ground height

Consider the gable wall of a two storey house on the crest of a hill near the centre of Hastings, Sussex at national grid reference 5810E 1100N (see map 3). The hill slopes downwards to the south-southeast, the house being about 1300 m from the sea in this direction. The surrounding area is built-up, with the nearest houses only about 25 m away, but since they are lower down they offer no protection. Consequently the terrain roughness category is 3, the terrain roughness factor is 0.75 (see table 3), but the obstruction factor is 1.0 (see figure 3 and table 5). To the south-southeast of the house, the land slopes down to the sea with an average slope a little steeper than 1 in 20. Therefore the topography factor is calculated using appendix C.

Figure A.4 is a cross section from the house to the sea, in the south-southeast direction. From appendix C:

- L , the length of the upwind slope, is 1300 m
- Z , the effective height of the feature, is 70 m
- S , the upwind slope, is 0.054 (i.e. Z/L)
- L_e , the effective length of the upwind slope, is 1300 m
- H , the height of the wall, is 7.5 m
- X , the horizontal distance of the wall from the crest, is 0 m

Therefore $H/L_e = 0.0058$ and $X/L_e = 0$

and from figure C.3

factor f is 1.0
therefore $T = 1 + 2.0Z_f/L = 1 + 2.0 \times 0.054 \times 1.0 = 1.1$

The average wall factor for a two storey gable wall is 0.4 (see table 6). The wall indices D_{WA} and D_{WS} for this wall can now be calculated as shown on the worksheet in figure A.5.

A.5 Effect of steeply sloping topography

Consider proposed walls at various locations on Truleigh Hill, Sussex at national grid reference 5226E 1108N. The proposed walls are north-facing, of height 7.5 m, and located at points 3, 4 and 6 on figure A.6. The average slopes between the points marked on figure A.6 are as follows:

Slope between

- 1 and 2 1 in 29
- 2 and 3 1 in 10
- 3 and 4 1 in 3
- 4 and 5 1 in 5
- 5 and 6 1 in 22

Truleigh Hill is part of a steeply sloping escarpment and the height of the feature may be assessed using the average level of the terrain upwind (to the north), which is the altitude of a point halfway between points 1 and 2.

Since the slopes upwind of points 3, 4 and 6 are steeper than 1 in 20, the topography factor is calculated using appendix C. The various calculations for these three points are given in table A.2. Figure C.2 is used to assess the value of f .

A.6 Calculation of run off

A.6.1 The possibility of run off for non-absorbent or saturated walls was referred to in 5.2.11.

Consider the example shown by the worksheet in figure A.5 and in addition a 10 storey, 30 m high building at the same site.

A.6.2 Figure A.5, two-storey gable wall, Hastings, Sussex

Wall height at gable apex = 7.0 m

D_{WS} = 29.6 l/m² per spell

D_{WA} = 132 l/m² per year

Since D_{WS} and D_{WA} were calculated using the average

Wall factor $W = 0.4$

Spell run off = $29.6 \times 7.0 = 207$ l/m width

Annual run off = $132 \times 7.0 = 924$ l/m width

Table A.2. Examples of calculation of topography factor T

Point	L	Z	S	L_e	H	X	H/L_e	X/L_e	f	T
	m	m		m	m	m				
3	590	30	0.05	590	7.5	520	0.01	0.88	0.1	1.01
4	920	142	0.15	920	7.5	190	0.008	0.21	0.7	1.22
6	1110	170	0.15	1110	7.5	0	0.007	0	1.0	1.31

NOTE. The distances L and Z are calculated with reference to a point halfway between points 1 and 2 in figure A.6, this being taken as the general level of the land upwind and the point where the escarpment begins.

A.6.3 Site in figure A.5, 10 storey block, Hastings, Sussex

Wall height	= 30 m
Average wall factor W	= $(0.5 \times 2.5 + 0.2 \times 27.5) \div 30$ (from table 6) = 0.225
Spell run off	= $D_S \times R \times T \times O \times$ average $W \times$ height = $89.8 \times 0.75 \times 1.1 \times$ $1.0 \times 0.225 \times 30$ = 500 l/m width
Annual run off	= $D_A \times R \times T \times O \times$ average $W \times$ height = $400 \times 0.75 \times 1.1 \times$ $1.0 \times 0.225 \times 30$ = 2228 l/m width

A.6.4 There are several factors which can significantly affect run off from walls and can lead to considerable discrepancies between calculated and practical values.

For example, an absorbent wall can significantly reduce run off as water becomes absorbed. Even after saturation rain penetration can occur and this too will reduce run off from the exposed surface. Site experiments on two storey cavity walls with brick outer leaves have demonstrated that as much as 80 % of incident rainfall can penetrate from the exposed surface into the cavity, although 20 % to 30 % is probably more typical.

Water can be thrown clear of the wall by projecting features such as string courses or cills. This water then tends to fall vertically, close to the wall, and it is not blown back into the surface.

NOTE. Run off intensity may be increased in certain locations if streaming occurs on the surface. This is more likely for smooth finishes than for textured.



(a) Houses 20 m away at opposite side of residential road on level ground. Obstruction factor 0.4



(b) Houses and trees at various distances. Nearest gable approximately 30 m away, furthest approximately 70 m. Obstruction factor estimated 0.6

Figure A.1. Typical views from example walls



(c) Line of sight to open country over roofs of nearest houses. Obstruction factor 1.0
NOTE. Terrain roughness category is 2, $R = 0.85$.



(d) View down open road to two storey houses, 130 m away. Obstruction factor 1.0

Figure A.1. Typical views from example walls (continued)



(e) Nearest houses 65 m away, others 85 m to 100 m. Slight drop in ground level to subject wall. Obstruction factor estimated 0.7

Figure A.1. Typical views from example walls (concluded)

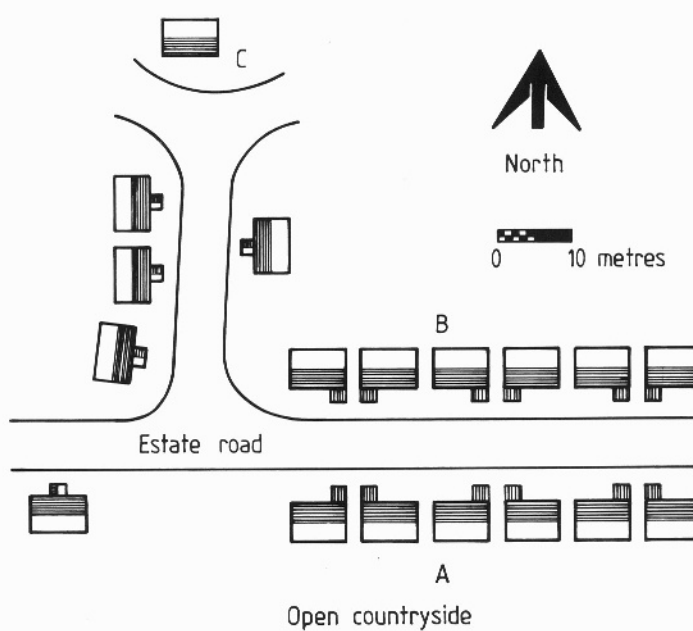


Figure A.2. Location of houses on southern edge of estate

Location: Hove, Sussex
Grid reference: 5)290E 1)044N
Orientation: N/S 0°/180°
Map subregion: PH1

		Spell index	Annual index
		N/S	N/S
Geographical increment	<i>i</i>	+ 1/ + 1	+ 1/ + 1
Rose value	<i>r</i>	15/26	2/15
Map value (<i>i</i> + <i>r</i>)	<i>m</i>	16/27	3/16
Airfield indices (table 1 or 2)		$D_S = 40/143$ l/m ² per spell	$D_A = 140/635$ l/m ² per year
Terrain roughness factor (table 3)	<i>R</i>	0.75/1.15	
Topography factor (table 4)	<i>T</i>	1.0/1.0	
Obstruction factor (table 5)	<i>O</i>	0.6/1.0	
Wall factor (table 6)	<i>W</i>	0.4/0.4	
Wall indices for the appropriate direction of wall		$D_{WS} = 7.2/65.8$ l/m ² per spell	$D_{WA} = 25.2/292.1$ l/m ² per year

Figure A.3. Typical worksheet for wind-driven rain calculations for north and south facing walls

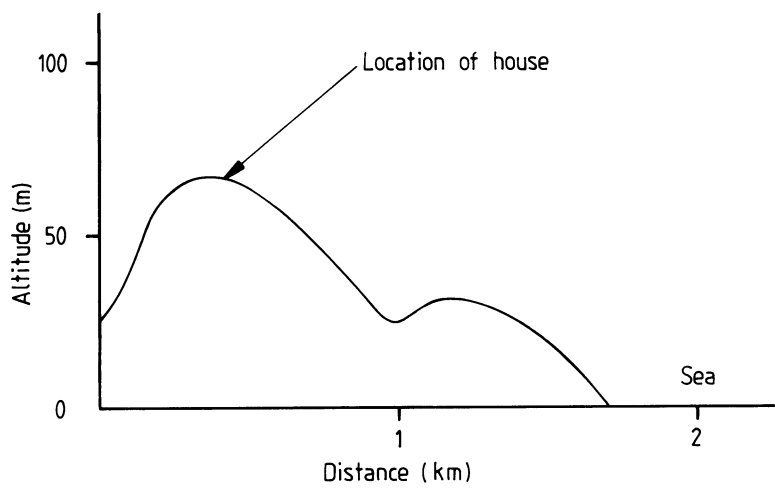
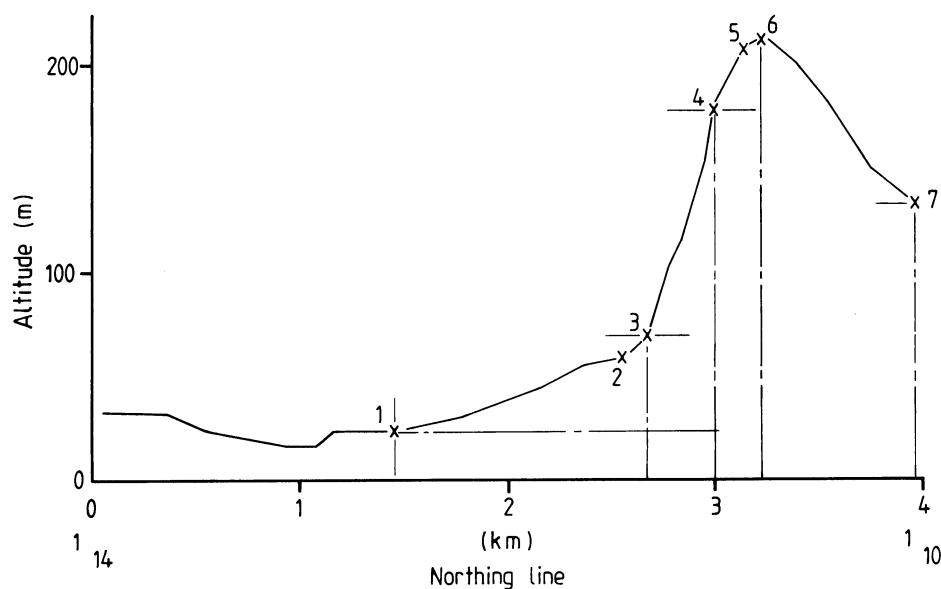


Figure A.4. Cross section of land in direction 150° (Hastings, Sussex)

Location: Hastings, Sussex
 Grid reference: ⁵810E ¹100N
 Orientation: 150°
 Map subregion: GK1

		Spell index	Annual index
Geographical increment	<i>i</i>	+1	+1
Rose value	<i>r</i>	22	11
Map value (<i>i</i> + <i>r</i>)	<i>m</i>	23	12
Airfield indices (table 1 or 2)		$D_S = 89.8$ l/m ² per spell	$D_A = 400$ l/m ² per year
Terrain roughness factor (table 3)	<i>R</i>	0.75	
Topography factor (table 4)	<i>T</i>	1.1	
Obstruction factor (table 5)	<i>O</i>	1.0	
Wall factor (table 6)	<i>W</i>	0.4	
Wall indices for the appropriate direction of wall		$D_{WS} = 29.6$ l/m ² per spell	$D_{WA} = 132$ l/m ² per year

Figure A.5. Worksheet for wind-driven rain calculations



Cross section through contours along easting line ⁵226

Figure A.6. Basic data. Truleigh Hill, Sussex