DRAFT FOR DEVELOPMENT

DD CEN/TS
15087:2005

Determination of the uplift resistance of installed clay and concrete interlocking tiles for roofing — Test method for mechanical fasteners

ICS 91.060.20; 91.100.30

BSI
British Standards

National foreword

This Draft for Development is the official English language version of CEN/TS 15087:2005.

This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature because it is considered that further experience is required in its application before it is converted into a European and hence British Standard. It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

Comments arising from the use of this Draft for Development are requested so that UK experience can be reported to the European organization responsible for its conversion to a European standard. A review of this publication will be initiated 2 years after its publication by the European organization so that a decision can be taken on its status at the end of its 3-year life. Notification of the start of the review period will be made in an announcement in the appropriate issue of *Update Standards*.

According to the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the conversion into a European standard, to extend the life of the Technical Specification or to withdraw it. Comments should be sent in writing to the Secretary of BSI Subcommittee B/542/1, Slating and tiling, at British Standards House, 389 Chiswick High Road, London W4 4AL, giving the document reference and clause number and proposing, where possible, an appropriate revision of the text.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Summary of pages

This document comprises a front cover, an inside front cover, the CEN/TS title page, pages 2 to 17 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

This Draft for Development was published under the authority of the Standards Policy and Strategy Committee on 9 February 2006

ISBN 0 580 47764 9

Amendments issued since publication

Amd. No.	Date	Comments

TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

TECHNISCHE SPEZIFIKATION

CEN/TS 15087

December 2005

ICS 91.060.20; 91.100.30

English Version

Determination of the uplift resistance of installed clay and concrete interlocking tiles for roofing - Test method for mechanical fasteners

Détermination de la résistance au soulèvement des tuiles à emboîtement en terre cuite ou en béton mises en oeuvre sur la toiture - Méthode d'essai des fixations mécaniques

Bestimmung des Abhebewiderstandes von verlegten Dachziegeln oder Betondachsteinen - Prüfverfahren für mechanische Verbindungselemente

This Technical Specification (CEN/TS) was approved by CEN on 1 March 2005 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. CEN/TS 15087:2005: E

Contents

Foreword

This Technical Specification (CEN/TS 15087:2005) has been prepared by Technical Committee CEN/TC 128 “Roof covering products for discontinuous laying and products for wall cladding”, the secretariat of which is held by IBN.

This document is applicable where the National application standards, and/or, regulations, specify a requirement for the uplift resistance of installed clay or concrete tiles for roofing.

No existing European Standard is superseded.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this CEN Technical Specification: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This Technical Specification specifies a test method for determining the strength and uplift resistance of fasteners for clay and concrete interlocking tiles for roofing.

NOTE 1 The results of this test may be used to determine the uplift force which can be withstood by the fastener; e.g. to withstand wind force.

NOTE 2 When the results of the test method for mechanical fasteners have a correlation to the results of the roof system test method [EN 14437] they can be used to establish the uplift resistance of installed clay and concrete tiles for roofing.

The test method is applicable to mechanical fasteners such as clips, hooks, screws and nails. It is not applicable to fasteners which hold down more than one tile.

2 Normative references

Not applicable.

3 Terms and definitions

For the purposes of this Technical Specification, the following terms and definitions apply.

3.1
characteristic value
value of a material property having a prescribed probability of not being attained in a hypothetical unlimited test series; this value generally corresponds to a specific fractile of the assumed statistical distribution of the particular property of the material

3.2
gauge
length of the exposed part of the fixed tile, measured longitudinally; this is the same as the batten gauge

3.3
mechanical fasteners
screws, clips, nails and hooks

4 Symbols and abbreviations

d_{max} maximum displacement of tile D (mm);

F test load, (N);

F_c force acting on the mechanical fastener;

F_0 test load without a fastener fitted (N);

$F_{i,\,MAX}$ maximum test load at failure (N);

k_n a factor depending on the number of tests n;

L_h hanging length (mm);

L_F distance between the pivot line and the applied uplift force (mm);

L_C distance between the pivot line and the centre of the clip (mm);

n number of tests;

R_d maximum design value;

R_k characteristic fastener uplift resistance (N);

R_i individual fastener uplift resistance (N);

R_x mean fastener uplift resistance (N);

s_x standard deviation of the uplift resistance (N);

γ partial safety factor for resistance, which may be defined by a national regulation;

F_t is the uplift force (N) acting in the centre of the exposed area of each tile or slate;

g is the acceleration due to gravity, 9,81 $ms^{-2;}$

q is the moment arm (m) shown in Figure E.1;

r is the moment arm (m) shown in Figure E.1;

w_t is the mass of one tile (kg);

p is the moment arm (m) shown in Figure E.1;

α is the angle of the tile or slate to the horizontal (degrees) when laid on the roof.

5 Sampling

The clay and concrete tiles for the roofing selected shall be representative of the tiles specified by the manufacturer.

The battens selected shall be representative, i.e., in line with the tile product and instructions of the clip manufacturer.

The fasteners used for the test shall be representative of the manufactured product.

In selecting the number of elements refer to Clauses 7 and 9, taking into consideration that in each case a trial test and at least 3 tests shall be conducted.

NOTE The specification of the battens may include a reference to a national code of practice.

6 Test conditions

Unless specified otherwise, the roofing tiles, fasteners and test frame shall be stored for at least 24 hours in an environment of (20 ± 5) °C, and (60 ± 20) % relative humidity, prior to the test. The manner of storage shall not interfere with the free exchange of moisture from or into the materials. The test shall be conducted in the same conditions as the storage.

NOTE If in practice, the moisture content of the battens is expected to be different from the standard conditions, and if it is expected that this may influence the test results, this should be taken into account; e.g. by testing under the appropriate conditions and recording the moisture content of the battens used.

7 Test material

The test materials shall be randomly chosen from the samples.

8 Apparatus

8.1 Test Rig

An example of the apparatus is shown in Annex A, and consists of:

a) a horizontal rigid base frame onto which is attached counter battens (to simulate rafters at the maximum intended rafter centres) and tiling battens set at the appropriate gauge. The top tiling batten shall be attached to the counter battens by hinges (see Annex B);

b) the tiles to be tested are fastened to the battens with tail clips fixed to the tail (lower half of tile) batten and/or nails/screws /head clips fixed to the head (top part of tile) batten;

c) a means of loading test sample via a load application device, capable of applying a loading rate of not less than 100 N/min initially in a direction normal to the tile surface at the loading point;

d) a load application device that includes a calibrated force-measuring device e.g. load cell. The load application device shall be hinged at both ends and the length of the device between the hinges should exceed the hanging length of the tile;

e) a rigid bar, incorporating an accurate system for locating and supporting a calibrated displacement-measuring device, the bar shall permit the tail of the fixed tile to be raised by $d_{\max}$ (see 9.2.3 d).

8.2 Force measuring device

A calibrated force-measuring device shall be used to determine the uplift force having a maximum inaccuracy in combination with the reading equipment of 1 % of the measured value or 10 N, whichever is the larger.

8.3 Measuring device for displacement of the roofing tiles

A calibrated displacement-measuring device shall be used to determine the displacement of the roofing tiles and shall have a maximum inaccuracy of 0,2 mm. The displacement-measuring device shall not exert forces larger than 1 % of the uplift force. The measuring device shall be able to measure displacements in excess of $d_{\max}$.

NOTE Other apparatus satisfying Clause 8 may also be used.

9 Test Procedure

9.1 Procedure for Setting up the Test

Fix the counter-battens (to simulate the rafters) to the base frame at 600 mm spacing. Fix the battens of appropriate dimensions to the counter-battens at the specified minimum gauge for the roofing element.

Referring to Figure 1 lay tiles A and B.

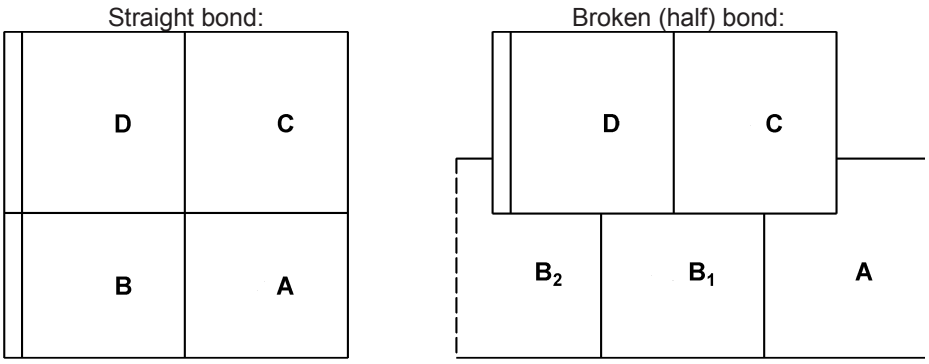


Figure 1: Arrangement of tiles (A, B, B_1, B_2, C, D are tiles)

The load application device shall be attached to tile C at the centre of its exposed area.

Lay tile C then attach and fix the fastener to the test sample in accordance with the relevant specification and normal standards of workmanship, then lay tile D without fastener.

Securely fix tiles C and D at their heads to the top (hinged) batten (e.g. by nails, screws, bolts or clamps). If the fixing configuration under test includes head fasteners then the head of tile C shall be fixed with the test head fasteners and the hinged batten replaced with a fixed batten and arrangements made to have a tile overlap tile C to allow the measurement of the residual displacement.

Attach the displacement-measuring device to its rigid support such that it measures the displacement of tile D over the fastener position and in a direction normal to the surface of tile D.

NOTE 1 The lower batten, supporting the tails of tiles A and B, will need to be of greater depth e.g. double batten than the other battens so that tiles A and B will lay parallel to tiles C and D in the final assembly.

NOTE 2 Care should be taken to ensure that the size and/or positioning of the hinges on the top batten does not interfere with the seating of the tiles.

NOTE 3 Most interlocking tiles are laid from right to left. If the test tiles are those which are laid from left to right then the arrangement shown in Annex A and Figure 1 should be treated as a mirror image with tile numbers and instructions adjusted accordingly.

NOTE 4 Most tiles can be laid in straight bond, but if they can only be laid in broken (half) bond then the alternative arrangement shown in Figure 1 should be used.

NOTE 5 For convenience, a small hole may be made through tile C at the centre of the exposed area for attaching the load application device.

NOTE 6 For preliminary tests lay tiles without fasteners (reference 9.2.1).

9.2 Procedure for conducting the test

9.2.1 Zero the measuring equipment

Carry out a preliminary test without a fastener in order to determine the test force, F_0, measured on the calibrated force-measuring device, required to lift tiles C and D by 10 mm when no fastener is fitted.

NOTE F_0, represents the influence of the self weight of the tiles C and D and eliminates the need to weigh these tiles and calculate moments.

9.2.2 Trial test

Carry out a trial test to determine the likely failure loads. This is carried out with a fastener fitted to tile C. The applied load F_i, is increased until one of the failure criteria a) to e) in 9.2.3 is reached. Record the maximum

applied load, $F_{\mathrm{i,\,MAX}}$, before failure is reached. In future tests, the load increments shall be chosen to be no greater than $F_{\mathrm{i,\,MAX}}$ / 5.

9.2.3 Test procedure

For each test, record any damage and the mode of failure of tile C or the fastener. Carry out the loading in not less than 5 increments and complete it within 15 minutes.

During each test, at each load increment, record the applied test force, F_{T}, from the calibrated force measuring device and the associated displacement of tile D. After the removal of each load increment record the residual upward displacement of tile D. Continue to incrementally increase the load until one of the following events occurs:

a) breakage of the mechanical fixing from tile to batten;

b) pulling out or breakage of the connection of the mechanical fixing to the roof;

c) breakage of the covering elements;

d) the measured displacement at the tail of tile D exceeds $d_{\max}$ (mm), given by,

$$d_{\max}\ (\mathrm{mm}) = 75 \times L_{\mathrm{h}} / 400 \qquad (1)$$

$d_{\max}$ is the maximum permissible displacement, in mm,

L_{h} is the hanging length of the tile, in mm;

e) the nib of any of the tiles on the test rig disengages from its batten;

f) the remaining displacement of any roofing tile due to deformations of the fixings after releasing the force to zero exceeds 5 mm.

Record $F_{\mathrm{i,\,MAX}}$ for each of the tests.

After each test a new mechanical fastener should be used. All roof elements should be replaced with new tiles and battens if there is any risk that a damaged sample would affect the test result. The tiles shall be installed in a manner that ensures the fixings do not coincide with the previous fixing positions within 30 mm.

Conduct at least 3 tests

NOTE 1 Before unloading the test tile, the fixing to the head of tile D will need to be slackened to avoid inducing a load in the fastener during unloading of tile C.

NOTE 2 The hanging length of the tile is the distance between the lower (free) end of the tile to the inner surface of the hanging nib.

The release of the pulling force in between various loading steps may cause a remaining displacement of the roofing tiles due to friction between the elements or between the elements and the roof substructure. If the remaining displacement exceeds 5 mm after releasing the force to zero, the elements shall be returned to less than 5 mm by pushing at right angles to the surface of the tiles by hand. The fixings shall not be influenced when returning the elements. If after returning all the elements, a value less than 5 mm cannot be achieved, failure will be deemed to have occurred according to 9.2.3 (condition f).

10 Evaluation and expression of results

The loads acting on the fastener can be calculated from the loads obtained from the force measuring device, $F_{\mathrm{i,max}}$, by taking moments about the hinged batten.

The individual fastener uplift resistance, R_i, should be calculated from the individual test load at failure, $F_{i,MAX}$:

$$R_i = (F_{i,MAX} - F_0) \times L_F/L_C, \quad (2)$$

where,

L_F is the distance between the pivot line and the applied uplift force (mm);

L_C is the distance between the pivot line and the centre of the clip (mm).

The individual fastener uplift resistance R_i, should be regarded as either the maximum fastener load or the fastener load corresponding to a total displacement of not exceeding d_{max}.

The mean value and the standard deviation of the fastener uplift resistance from the tests shall be calculated by:

$$R_x = 1/n \sum R_i \quad (3)$$

$$s_x = [\sum (R_i - R_x)^2/(n-1)]^{0,5} \quad (4)$$

When after a series of three tests, the ratio of s_x/R_x exceeds 0,15, two additional tests in accordance with 9.3.3 shall be carried out; when the ratio s_x/R_x still exceeds 0,15 after five tests, two additional tests in accordance with 9.3.3 shall be carried out. The mean value, R_x, and the standard deviation, s_x, shall be calculated on the basis of the number of tests completed, i.e., 3, 5 or 7.

NOTE Annex C contains information on the calculation of the characteristic value of the fastener uplift resistance R_k, and Annex D on the calculation of the maximum design value of the clip resistance, R_d.

11 Test report

The report shall provide the following information:

a) the title, reference number and date of the publication of this document;

b) the place, date and time of sampling;

c) the identification of the roofing tile according to the relevant standard, the commercial identification of the roofing tiles, including material specifications, surface characteristics and name of the manufacturer;

d) the head and side lap and the bonding of the installed roofing tiles;

e) the type, name and dimensions of the fastener including any associated nail and material specifications and the name of the manufacturer;

f) the number of tiles that have been fixed and the distribution of the fasteners;

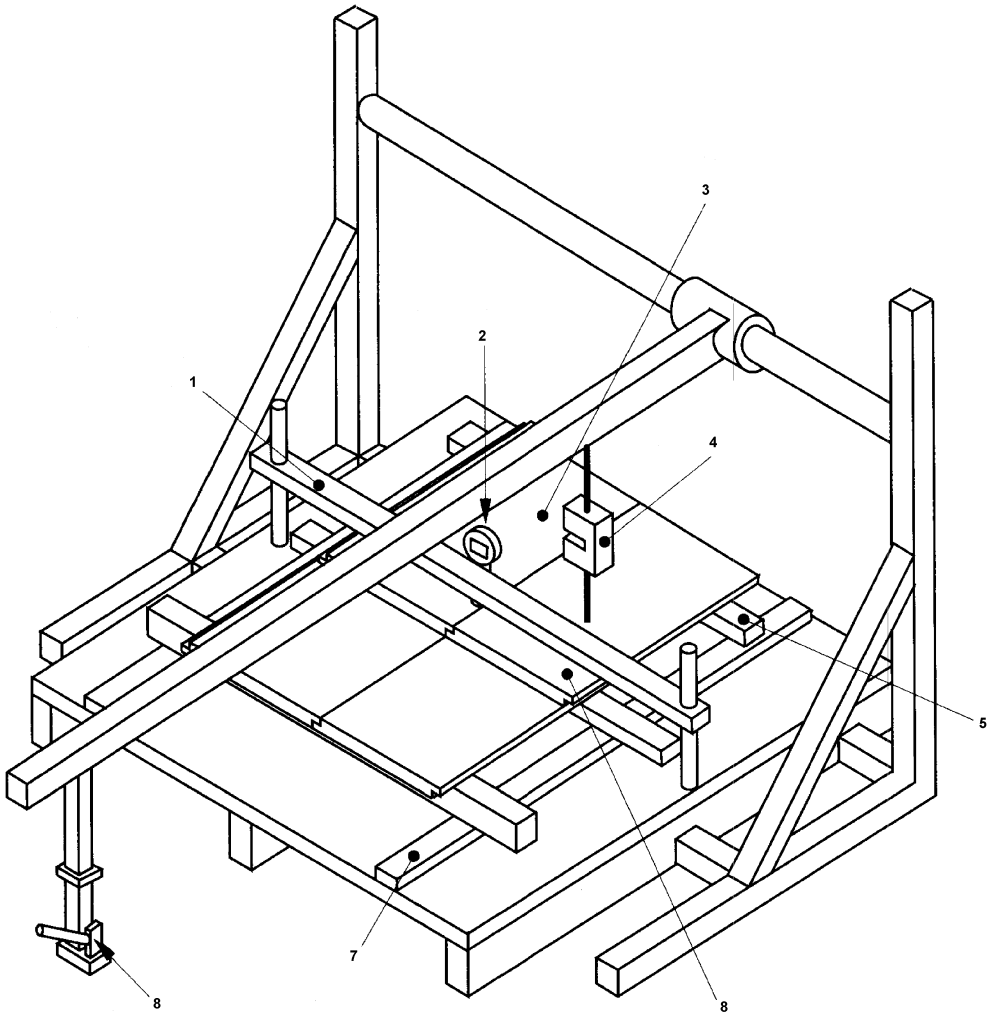
g) the species or density of the timber used for battens, dimensions and span of the battens, and, the moisture content of the battens;

h) the test results(individual values, mean and standard deviation and modes of failure);

i) any other factor that could have influenced the result.

Annex A
(informative)

Example of an arrangement of the test apparatus for determination of fastener strength



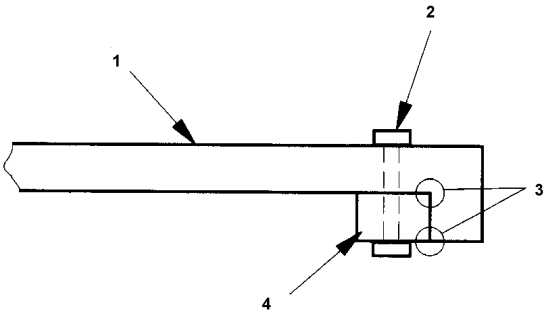
Key

1 Bar to attach displacement measuring device
2 Displacement measuring device
3 Unfixed test tile
4 Load cell
5 Hinged batten
6 Load application device
7 Counterbattens to simulate rafters
8 Fixed test tile

Figure A.1: Example of an arrangement of the test apparatus

Annex B
(informative)

Hinged batten for supporting a test tile



Key

1 Bar to attach displacement measuring device
2 Displacement measuring device
3 Unfixed test tile
4 Load cell

Figure B.1: Top tiling batten attached to counter battens by hinges

Annex C
(informative)

Calculation of characteristic values

The characteristic values of the fastener uplift resistance may be determined on a 5 % lower bound by:

$$R_k = R_x - k_n \times s_x \quad \text{(C.1)}$$

Where k_n is obtained from Table C.1

Table C.1 — Values of k_n

No. of test results, n	3	5	7
k_n	3,37	2,33	2,08

Annex D
(informative)

Maximum design value of the uplift resistance

The maximum design value of the fastener uplift resistance R_d may be calculated from the characteristic value using a partial safety factor as follows:

$$R_d = R_k/\gamma \quad \text{(D.1)}$$

γ is a partial safety factor for resistance which may be defined in National codes of practice.

Annex E
(informative)

Force actions on clip in an assembly of roofing elements

To find the force, F_c, acting on a tail clip attached to one side of a tile in an array of similarly clipped tiles with no other fixings.

A tile lapping on all four edges with contiguous tiles and clipped on one edge at C is subjected to a system of forces (loads and reactions) acting perpendicularly to the plane of the tile as follows:

uplift load F_t;

self weight resistance, w_t.

The wind distribution is taken as a load (wind pressure $\times$ area) in the centre of the tile and F_t is the net uplift load acting in the centre of the exposed area of the tile.

Reactions A at two points: one upwards at the left hand tail corner due to uplift forces from the course lapping under; and the other downwards near the head of the tile where the upper course headlap provides a holding down force. In the latter case, the holding down position depends on whether the tiles are laid in straight or broken bond as shown in Figure E.1.

Batten reaction or upward force at P, a point along the upper edge of the batten. For a flat tile the point P occurs at the left-hand edge and for a profiled tile it occurs close to the left-hand edge of the left-hand nib.

To find the load on the clip, F_c, take moments using lever arms that are at right angles to the axis A-A, and use the following equation:

$$F_c = F_t \times q/r - (w_t \times g \times p \times \cos \alpha)/r \qquad \text{(E.1)}$$

Where:

F_t is the uplift force (N) acting in the centre of the exposed area of each tile or slate;

g is the acceleration due to gravity, 9,81 ms^{-2};

q is the moment arm (m) shown in Figure E.1;

r is the moment arm (m) shown in Figure E.1;

w_t is the mass of one tile (kg);

p is the moment arm (m) shown in Figure E.1;

α is the angle of the tile or slate to the horizontal (degrees) when laid on the roof.

The formula for F_c has to be modified for the case of tiles with clips as well as other fixings such as head nails. In this case, the line of rotation of the tile under uplift load F_t is likely to be about the batten bearing edge at the head of the tile.

NOTE The values of p, q and r depend on whether the tiles are laid in straight bond or broken bond.

Example calculation

Single lap double-S profile tiles, lapping on all four edges, are to be fixed on a roof, all tiles being fixed with a single clip immediately above the headlap. The tiles are to be laid in straight bond with rafter pitch of 25 °C and a headlap of 75 mm. The roof, the site and the surrounding terrain have been assessed and the design wind load, F_t, on tiles is 58 N.

For this tile, laid as described:

F_t = 58 N

q = 0,234 m

r = 0,166 m

W_t = 4,3 kg

p = 0,200 m

α = 20,5°

The load in the clip, under the design wind load, will then be:

$F_c = 58 \times 0{,}234/0{,}166 - (4{,}3 \times 9{,}81 \times 0{,}200 \times \cos 20{,}5)/0{,}166$

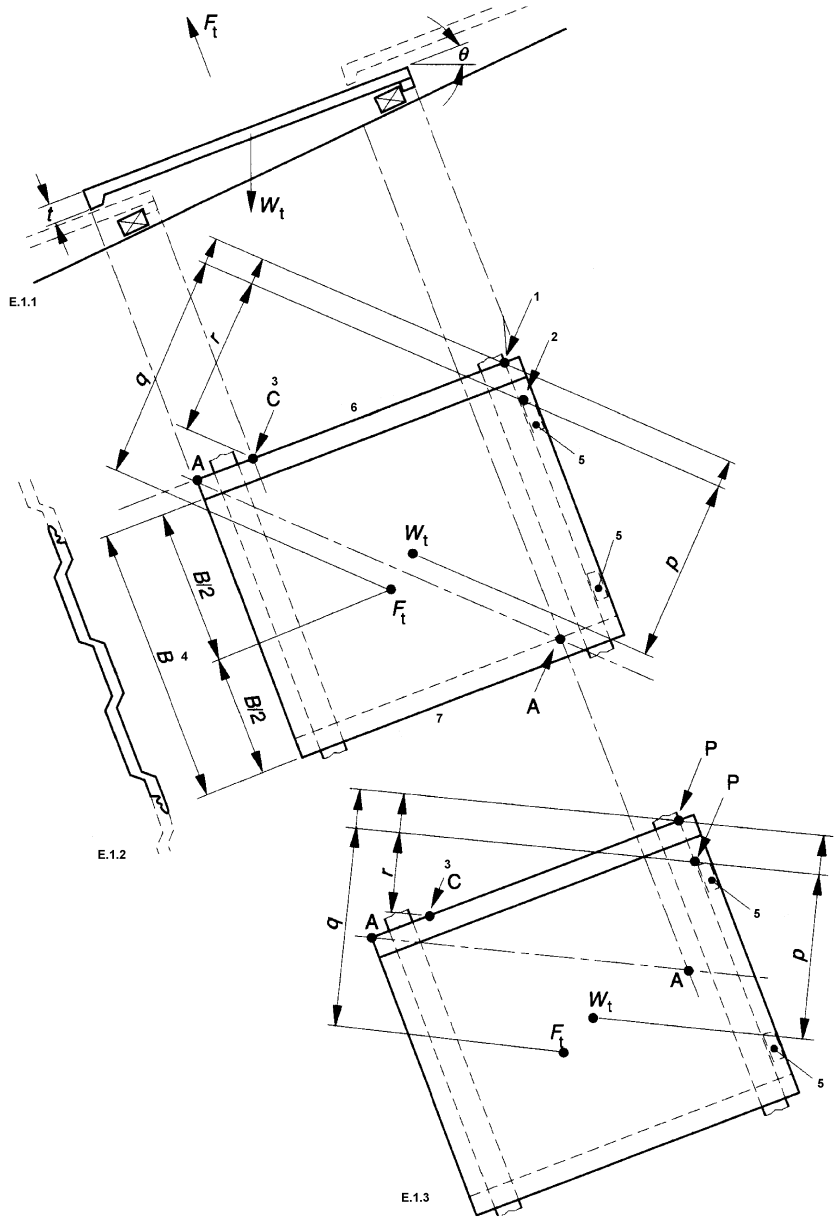
F_c = 34,2 N

In this instance, for the clips to be an adequate fixing by themselves the maximum design value of the clip uplift resistance, R_d, must exceed F_c. That is R_d > 34,2 N.

Comparison to test results

When comparing the wind uplift force to the uplift resistance test result the following should apply

$$F_c \leq R_d \qquad \text{(E.2)}$$



Key

E.1.1 Section showing typical single lap tile

E.1.2 Laid in straight bond

E.1.3 Laid in broken bond

1 Alternative position for P – for flat tile

2 Alternative position for P – for profile tie

3 Clip

4 Cover width

5 Nib

6 Left hand edge

7 Right hand edge

Figure E.1 — System of forces in an array of clipped tiles under uplift load

Bibliography

[1] EN 14437, *Determination of the uplift resistance of installed clay or concrete tiles for roofing — Roof system test method.*

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL