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Hygrothermal performance of buildings - Resistance to wind-driven rain of roof coverings with discontinuously laid small elements - Test method

Wärme- und feuchteschutztechnisches Verhalten von Gebäuden - Widerstand von Dacheindeckungen aus kleinformatigen, überlappend gedeckten Dachelementen gegen Schlagregen - Prüfverfahren

Performance hygrothermique des bâtiments - Résistance a la pluie battante de couvertures en petits éléments posés en discontinu - Méthode d'essai

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Hygrothermal performance of buildings - Resistance to wind - driven rain of roof coverings with discontinuously laid small elements - Test methods

Performance hygrothermique des bâtiments - Résistance à la pluie battante de couvertures en petits éléments posés en discontinu - Méthodes d'essai

Wärme- und feuchteschutztechnisches Verhalten von Gebäuden - Widerstand von Dacheindeckungen aus kleinformatigen, überlappend gedeckten Dachelementen gegen Schlagregen - Prüfverfahren

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Foreword

This document (CEN/TR 15601:2012) has been prepared by Technical Committee CEN/TC 89 “Thermal performance of buildings and building components”, the secretariat of which is held by SIS.

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Introduction

The extent to which roof coverings can resist water penetration from the combination of wind and rain, commonly referred to as wind driven rain, is important for the design of roofs. This CEN Technical Report describes a method of test to determine the performance of the roof covering against wind driven rain.

The combined action of wind and rain varies considerably with geographical location of a building and the associated differences in the rain and wind climate. Wind-rain climate zones are specified for: Northern Europe Coastal, Central Europe and Southern Europe. Each climate zone is divided into four wind-rain sub-tests (including a deluge condition).

This Technical Report does not contain information on the level of acceptable performance. The use of test results is given in Annex C.

In case of reference should be made to testing according to this document the word "shall" is used at the appropriate places.

1 Scope

This Techncial Report describes a method of test for determining the resistance of pitched roof coverings to wind-driven and deluge rain.

The test method is applicable to discontinuously laid unsealed small roof covering elements such as clay tiles, concrete tiles, slates, fibre cement slates and stones.

NOTE The test method may be adapted for fittings.

2 Normative References

This document contains no normative references.

3 Terms and definitions

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

3.1
test specimen
assembled array of elements for testing over which water leakage is to be observed or measured, excluding perimeter elements with sealed joints

3.2
set of tests
consisting of sub-tests B and D, (and optionally subtests A and C), for an appropriate climate zone, roof pitch and laying specification

Note 1 to entry: The sub-tests A, B, C and D are defined in Clause 8.

3.3
reference leakage rate
leakage rate of 10 g/m^2/5 min, 5-minutes being the duration of a single test step in the sub-test

4 Symbols and units

Symbol	Quantity	Unit
f	wind speed factor relating u and u_s	-
I_u	turbulence intensity	%
L	Simulated additional rafter length above the test specimen	m
R_h	rainfall rate on a horizontal plane	mm/h
R_{ro}	run-off rate	l/min
R_t	rainfall rate on the roof surface	mm/h
u	wind speed approaching the roof	m/s
u_t	terminal velocity of rain drops	m/s
σ_g	Standard deviation of the turbulent fluctuations in the wind speed	m/s
$\bar{u}$	Mean wind speed approaching the roof	m/s
u_s	wind speed over test specimen	m/s
W	the effective width of the test specimen	m
α	roof pitch	Degree°
θ	angle of incidence of rain	Degree°

5 Principle

A test specimen is fitted into the wind-driven rain apparatus, the external surface of the test specimen is exposed to wind and continuously sprayed with water, and run-off water is continuously applied at the top of the specimen. At the same time an air pressure difference between the upper and lower surfaces of the test specimen is increased or decreased in specific steps.

Water leakage through the test specimen, which can occur at certain air pressure differences, is observed and measured.

6 Test specimens

6.1 Test specimen samples

Samples for the test specimen shall comply, where relevant, with the appropriate product standard in respect of the appropriate sampling plan, or, in absence of a standard sampling plan, shall be selected at random from a representative population.

Discontinuously laid small elements for the test specimen shall be surface dry.

6.2 Dimensions of the test specimen

The dimensions of the test specimen shall be as large as necessary to be representative of the intended use.

The joints of elements in the test specimen shall be representative, e.g. the same length per square meter as designed for its intended use.

The test specimen shall comprise a minimum of 9 roof covering elements, a minimum length of 1,0 m and a minimum width of 1,0 m on a rectangular format.

6.3 Number of sets of tests

The number of sets of tests shall be at least one.

6.4 Preparation of test specimen

Construct the test specimen according to the roofing specification representative of its intended use (such as roof pitch, lap and the influence of fixing systems where appropriate).

The test specimen may be built in a surrounding frame to facilitate transport and fitting to the opening of the driving rain test apparatus. The joint between test specimen and surrounding frame shall be sealed to prevent water leakage during the test, without disturbance to joints between the discontinuously laid elements.

If a frame is used, it shall be able to resist the pressures applied during the test without deflecting to an extent that would influence the test results. The surround shall be prepared and installed so that any water penetration through the unsealed area of the test specimen is readily detectable.

The test specimen shall be conditioned to be surface dry before each test.

7 Apparatus

7.1 General

The test apparatus shall consist of:

— a suction chamber sealed to the underside of the test specimen and connected to a suction fan, as specified in 7.2;

— a fan system to create wind on the outside of the test specimen, as specified in 7.3;

— an installation capable of generating rain on the outside of the test specimen, as specified in 7.4;

— provisions for creating run-off water on the outside of the test specimen, as specified in 7.5; and

— facility for observation and measurement of leakage as specified in 7.6.

Examples of wind-driven rain apparatus are illustrated in Annex A.

NOTE Apparatus of different design is likely to produce different wind driven rain test results, but can produce consistent comparisons of performance between different roof covering elements.

7.2 Suction chamber

The suction fan connected to the suction chamber shall be capable of creating a stable pressure difference, maintained for 5 minutes ± 10 seconds, across the test specimen. The pressure difference shall be measured to a maximum inaccuracy of 1 % or 2,5 Pa, whichever is greater. The height and shape of the suction chamber shall be sufficient to ensure uniform pressure conditions.

It shall be possible, when required, to seal the connection between the suction chamber and the suction fan (e.g. by providing a valve, which can be closed or opened).

A water collector shall be provided, connected to the suction chamber, capable of recording the amount of leakage water during any pressure step in the test, to a maximum inaccuracy of 2 % or 1 g, whichever is greater. The surfaces of the suction chamber shall allow leakage water to flow freely into the water collector.

7.3 Fan system

The fan system shall be capable of generating wind in the direction of the eaves to the ridge. The wind flow shall be horizontal or parallel to the surface of the inclined test specimen.

Calibrate the fan system for spatial variation of the wind speed, by taking measurements at not less than 9 positions uniformly distributed, at a height of 200 ± 10 mm over a flat boarded area which replaces the test specimen for the purposes of the calibration, at the relevant roof pitch. The calibration wind speed shall be (10 ± 0,5) m/s at the centre of the test specimen.

The spatial variation of the wind speed shall be not more than ±15 % over the test specimen.

Wind speed shall be measured to a maximum inaccuracy of 0,5 m/s.

The turbulence intensity I_u in the oncoming wind shall be less than 10 % at each position. The turbulence intensity I_u (%) is expressed as $I_u = 100\sigma_g / \bar{u}$, where σ_g and $\bar{u}$ are the standard deviation of the turbulent fluctuations in the wind speed and mean wind speeds respectively, measured over a duration of not less than 5 minutes for this purpose.

Mean wind speed

$$\bar{u} = \frac{\sum_{i=1}^{n} u_i}{n} \quad (1)$$

Standard deviation

$$\sigma_g = \sqrt{\frac{\sum_{i=1}^{n} (u_i - \bar{u})^2}{n-1}} \quad (2)$$

where

u_i are individual wind speed measurements;

n is the number of wind speed

7.4 Rain generating installation

The installation shall be capable of supplying a stable rain rate (± 5%) as given in Table 2 for the roof pitch under test. The spatial variation shall be not more than ± 35 % over the area of the test specimen during a period of 5 minutes ± 10 seconds.

The rain droplet size shall be representative of natural rain, predominantly in the range of 0,6 mm to 2,5 mm diameter.

NOTE 1 Water droplets introduced into a high velocity air stream tend to break up over distance. Accordingly, it is recommended that the droplets are introduced far enough above the test specimen for this process to be completed and for the droplets to achieve the required velocity prior to impact with the test specimen.

NOTE 2 A variation of ± 35 % in wind driven rain distribution when combined with run-off water (see 7.5) results in a combined variation of not more than 10 %.

To calibrate the rain falling directly on the test specimen, replace the test specimen with a flat board which incorporates rainfall measuring devices in its upper surface. The measuring devices shall each be between 0,10 m^2 and 0,20 m^2 in plan area and arranged so that they do not collect any run-off water during calibration. The rain shall be measured to a maximum inaccuracy of 3 % or 0,2 mm/h, whichever is larger.

Calibrate the uniformity of rain distribution for each roof pitch and each test A, B, C and D (see Clause 8) as appropriate.

7.5 Run-off water

Run-off water to simulate the rafter length of the roof above the position of the test specimen, shall be evenly distributed across the top of the test specimen with a maximum deviation of not more than 10 % over the width of the test specimen. The quantity of run-off water shall be measured to a maximum inaccuracy of 3 %.

Precautions should be taken to avoid unrepresentative distribution of run-off water on the uppermost course of roof covering elements which, for example, could cause premature leakage through their sidelaps.

NOTE As a precaution, the sidelaps in the uppermost course of roofing elements may be sealed.

7.6 Observation and measurement of leakage

The suction chamber shall be provided with:

a) a transparent under-surface for clear visual observation of the nature and position of leakages which may appear on the underside of the test specimen during the test;

b) an apparatus to continuously collect and measure the amount (by weight or by volume) of leakage water which may fall from the test specimen into the suction chamber during the test.

To minimize surface tension, absorption and retention of water on the internal surfaces of the suction chamber, the surfaces shall be smooth, non-absorbent and inclined at a vertical angle of not less than 15° from the horizontal towards the lower collecting apparatus during testing.

8 Test procedure

8.1 General

Carry out the test in an environment with a temperature of between 5 °C and 35 °C with the test specimen installed in the apparatus at the specified roof pitch.

Seal the edges of the test specimen to prevent leakage of water or air into or out of the suction chamber. Such seals shall not affect the headlaps and sidelaps of the unsealed areas of the test specimen.

Select and continuously apply the relevant wind speed, rain-fall rate, and amount of run-off water according to the conditions specified in 8.2. The test specimen shall be surface dry before testing.

In the wind-driven rain sub-tests (A, B and C), measure initially the pressure difference with the suction chamber closed and adopt this pressure difference as the reference datum for subsequent pressure changes during the sub-test. Then reduce the pressure in the box in steps of from 5 Pa to 10 Pa and maintain each pressure step for 5 minutes ± 10 seconds. Measure the amount of leakage water (if any) at each pressure step, or continuously, up to the reference leakage rate.

NOTE 1 The test can be continued to greater pressure differences to observe additional leakage rates.