SLOVENSKI STANDARD
SIST EN 14315-1:2013

01-maj-2013

Toplotnoizolacijski proizvodi za stavbe - Proizvodi iz brizgane poliuretanske pene (PUR) in poliizocianuratne pene (PIR), oblikovani na mestu vgradnje - 1. del: Specifikacija penastega sistema pred vgradnjo

Thermal insulating products for buildings - In-situ formed sprayed rigid polyurethane (PUR) and polyisocyanurate (PIR) foam products - Part 1: Specification for the rigid foam spray system before installation

Wärmedämmstoffe für das Bauwesen - An der Verwendungsstelle hergestellte Wärmedämmung aus Polyurethan (PUR)- und Polyisocyanurat (PIR)-Spritzschaum - Teil 1: Spezifikation für das Schaumsystem vor dem Einbau

Produits isolants thermiques destinés aux applications du bâtiment - Produits en mousse rigide de polyuréthanne (PUR) ou de polyisocyanurate (PIR) injectée in situ par projection - Partie 1: Spécifications relatives aux systèmes d'injection du polyuréthanne ou du polyisocyanurate avant mise en oeuvre

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ICS:

91.100.60	Materiali za toplotno in zvočno izolacijo	Thermal and sound insulating materials

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Thermal insulating products for buildings - In-situ formed sprayed rigid polyurethane (PUR) and polyisocyanurate (PIR) foam products - Part 1: Specification for the rigid foam spray system before installation

Produits isolants thermiques destinés aux applications du bâtiment - Produits en mousse rigide de polyuréthanne (PUR) ou de polyisocyanurate (PIR) projetée, formés en place - Partie 1: Spécifications relatives aux systèmes de projection de mousse rigide avant mise en oeuvre

Wärmedämmstoffe für das Bauwesen - An der Verwendungsstelle hergestellter Wärmedämmstoff aus Polyurethan (PUR) - und Polyisocyanurat (PIR)-Spritzschaum - Teil 1: Spezifikation für das Schaumsystem vor dem Einbau

This European Standard was approved by CEN on 17 November 2012.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 14315-1:2013) has been prepared by Technical Committee CEN/TC 88 “Thermal insulating materials and products”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2013, and conflicting national standards shall be withdrawn at the latest by July 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

This European Standard consists of two parts which form a package. The first part is the harmonised part satisfying the mandate and the CPD and is the basis for the CE marking covering the products, which are placed on the market. The second part, which is the non-harmonised part, covers the specification for the installed products. Both parts need to be used for the application of the insulation products in the end-use applications covered by EN 14315.

This European Standard is one of a series for mineral wool, expanded clay, expanded perlite, exfoliated vermiculite, polyurethane/polyisocyanurate, cellulose, bound expanded polystyrene and expanded polystyrene in-situ formed insulation products used in buildings, but this standard may be used in other areas where appropriate.

The reduction in energy used and emissions produced during the installed life of insulation products exceeds by far the energy used and emissions made during the production and disposal processes.

EN 14315, *Thermal insulating products for buildings — In-situ formed sprayed rigid polyurethane (PUR) and polyisocyanurate (PIR) foam products*, consists of the following parts:

— *Part 1: Specification for the rigid foam spray system before installation* (the present document)

— *Part 2: Specification for the installed insulation products*

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies requirements for in-situ formed sprayed rigid polyurethane (PUR) and rigid polyisocyanurate (PIR) foam products when applied to walls, ceilings, roofs, suspended ceilings and floors.

This Part 1 of this European Standard is a specification for the rigid foam spray system before installation.

Part 1 of this European Standard describes the product characteristics and includes procedures for testing, marking and labelling and the rules for evaluation of conformity.

This European Standard does not specify the required levels of all properties to be achieved by a product to demonstrate fitness for purpose in a particular end-use application. The required levels are to be found in regulations or non-conflicting standards.

This European Standard does not cover factory made rigid polyurethane (PUR) or polyisocyanurate (PIR) foam insulation products or in-situ products intended to be used for the insulation of building equipment and industrial installations.

NOTE Foam products are either called flexible or rigid. The flexible products are used in upholstery and mattresses and are characterised by their ability to deflect, support and recover to their original thickness continually during their in-use phase. Those that are not flexible are termed rigid and do not possess these flexible characteristics. They are mostly used for thermal insulation purposes and vary widely in their compression strength values. Once the cell structure is crushed in a rigid foam, it does not recover its thickness fully. Some of these rigid foams are very low in density with very low compression strengths and are sometimes described “commercially” as “soft foams” or “semi-rigid” foams. This note has been included to clarify that all foams with such descriptions are covered by this standard’s used of the term rigid foam.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 312, *Particleboards — Specifications*

EN 508-1, *Roofing products from metal sheet — Specification for self-supporting products of steel, aluminium or stainless steel sheet — Part 1: Steel*

EN 520, *Gypsum plasterboards — Definitions, requirements and test methods*

EN 823, *Thermal insulating products for building applications — Determination of thickness*

EN 826, *Thermal insulating products for building applications — Determination of compression behaviour*

EN 1602, *Thermal insulating products for building applications — Determination of the apparent density*

EN 1604, *Thermal insulating products for building applications — Determination of dimensional stability under specified temperature and humidity conditions*

EN 1605, *Thermal insulating products for building applications — Determination of deformation under specified compressive load and temperature conditions*

EN 1606, *Thermal insulating products for building applications — Determination of compressive creep*

EN 1607:1996, *Thermal insulating products for building applications — Determination of tensile strength perpendicular to faces*

EN 1609, *Thermal insulating products for building applications — Determination of short term water absorption by partial immersion*

EN 12086, *Thermal insulating products for building applications — Determination of water vapour transmission properties*

EN 12667:2001, *Thermal performance of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Products of high and medium thermal resistance*

EN 12939, *Thermal performance of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Thick products of high and medium thermal resistance*

EN 13172:2012, *Thermal insulation products — Evaluation of conformity*

EN 13238, *Reaction to fire tests for building products — Conditioning procedures and general rules for selection of substrates*

EN 13501-1, *Fire classification of construction products and building elements — Part 1: Classification using test data from reaction to fire tests*

EN 13823:2010, *Reaction to fire tests for building products — Building products excluding floorings exposed to the thermal attack by a single burning item*

EN ISO 354, *Acoustics — Measurement of sound absorption in a reverberation room (ISO 354)*

EN ISO 1182, *Reaction to fire tests for products — Non-combustibility test (ISO 1182)*

EN ISO 1716, *Reaction to fire tests for products — Determination of the gross heat of combustion (calorific value) (ISO 1716)*

EN ISO 9229:2007, *Thermal insulation — Vocabulary (ISO 9229:2007)*

EN ISO 11654, *Acoustics — Sound absorbers for use in buildings — Rating of sound absorption (ISO 11654)*

EN ISO 11925-2:2010, *Reaction to fire tests — Ignitability of products subjected to direct impingement of flame — Single-flame source test (ISO 11925-2:2010)*

ISO 4590, *Rigid cellular plastics — Determination of the volume percentage of open cells and of closed cells*

3 Terms, definitions, symbols and abbreviations

For the purposes of this document, the terms and definitions given in EN ISO 9229:2007 and the following apply.

3.1 Terms and definitions

3.1.1
polyurethane foam PUR
(in-situ formed products)
rigid cellular plastics insulation material or product with a structure based on polymers mainly of the polyurethane type

3.1.2
polyisocyanurate foam PIR
(in-situ formed products)
rigid cellular plastics insulation material or product with a structure based on polymers mainly of the polyisocyanurate type

3.1.3
polyurethane foam PU
rigid cellular plastics insulation materials or products including both polymer types based mainly on polyurethane (PUR) or mainly on polyisocyanurate (PIR) groups

3.1.4
rigid foam spray system
kit of constituent components which when sprayed generates the rigid polyurethane (PUR) foam or the rigid polyisocyanurate (PIR) foam characterised by the specified properties of the foam generated

3.1.5
isocyanate component
liquid isocyanate product which is one of the components of the rigid foam spray system

3.1.6
polyol component
liquid polyhydroxyl product containing an expanding agent, catalysts and other additives which is one of the components of the rigid foam spray system

3.1.7
cream time
time which has elapsed between the time at which the stirring procedure for the mixed components was started and the moment when the foam is observed as starting to rise (usually measured in seconds)

3.1.8
gel time

time which has elapsed between the time at which the stirring procedure for the mixed components was started and the moment when, by means of a rod (or a match) applied into the surface of the foam, a polymeric string can be drawn from the foam surface (usually measured in seconds)

3.1.9
tack-free time
time which has elapsed between the time the stirring procedure for the mixed components was started and the moment when, by means of a rod (or a match) applied to the top surface of the foam, the top surface is established as no longer tacky (usually measured in seconds)

3.1.10
free-rise density
density of the unfaced cut test specimen taken from the reaction profile test sample (see E.5)

3.1.11
mixing ratio
proportions of the components of the rigid foam spray system specified by the manufacturer to be sprayed to generate the rigid polyurethane or polyisocyanurate foam

Note 1 to entry: This can be expressed either as a weight or a volume ratio or both.

3.1.12
production batch
amount of a component produced discontinuously in a single period of time of a rigid foam system

3.1.13
level
given value which is the upper or lower limit of a requirement, where the level is given by the declared value of the characteristic concerned

3.1.14
class
combination of two levels of the same property between which the performance shall fall, where the level is given by the declared value of the characteristic concerned

3.2 Symbols and abbreviations

3.2.1 Symbols used in this standard

α_p	is the practical sound absorption coefficient	-
α_w	is the weighted sound absorption coefficient	-
d_N	is the nominal thickness of the product	mm
$\Delta\varepsilon_l$	is the relative change in length	%
$\Delta\varepsilon_b$	is the relative change in width	%
$\Delta\varepsilon_d$	is the relative change in thickness	%
ε_{ct}	is the compressive creep	%
ε_t	is the total thickness reduction	%
k	is a factor related to the number of test results available	-
k_a	is a factor related to the number of aged test results	-
k_i	is a factor related to the number of initial test results	-
$\lambda_{90/90}$	is the 90 % fractile with a confidence level of 90 % for the thermal conductivity	W/(m·K)
λ_D	is the declared thermal conductivity (aged)	W/(m·K)
λ_i	is one test result of thermal conductivity	W/(m·K)
λ_{mean}	is the mean thermal conductivity	W/(m·K)
$\lambda_{mean,a}$	is the mean thermal conductivity of aged values	W/(m·K)
$\lambda_{mean,i}$	is the mean thermal conductivity of initial values	W/(m·K)
$\Delta\lambda_a$	is the ageing increment from measured aged values of thermal conductivity	W/(m·K)
$\Delta\lambda_f$	is the fixed ageing increment	W/(m·K)
μ	is the water vapour diffusion resistance factor	-
n	is the number of test results	-
$R_{90/90}$	is the 90 % fractile with a confidence level of 90 % for the thermal resistance	m^2K/W
R_D	is the declared thermal resistance	m^2K/W
R_i	is one test result of thermal resistance	m^2K/W
R_{mean}	is the mean thermal resistance	m^2K/W
s_λ	is the estimate of the standard deviation of the thermal conductivity	W/(m·K)
$s_{\lambda a}$	is the estimate of the standard deviation of the aged values of thermal conductivity	W/(m·K)
$s_{\lambda i}$	is the estimate of the standard deviation of the initial values of thermal conductivity	W/(m·K)
s_R	is the estimate of the standard deviation of the values of thickness	m
σ_{10}	is the compressive stress at 10 % deformation	kPa
σ_a	is the substrate adhesion strength perpendicular to faces	kPa
σ_c	is the declared stress for determination of compressive creep	kPa
σ_m	is the compressive strength	kPa
W_p	is the short term water absorption by partial immersion	kg/m^2

3.2.2 Designation codes used in this standard

AP(d) is the symbol for the declared level of practical sound absorption coefficient with d for the thickness or the range of thicknesses, expressed in millimetres, in which the declared value is valid

AW(d)	is the symbol for the declared level of weighted sound absorption coefficient with d for the thickness or the range of thicknesses, expressed in millimetres, in which the declared value is valid
A	is the symbol for the declared level of substrate adhesion strength
$CC(i_1,i_{2,}y)\sigma_c$	is the symbol for the declared level for compressive creep with i_1 for the total reduction in thickness level, i_2 for the compressive creep level, y for the corresponding time in years and σ_c for the declared compression extrapolated deformation and y for the corresponding time in years
CCC	is the symbol for the declared level for closed cell content
CS(10\Y)	is the symbol for the declared value for compressive stress or strength
CT	is the symbol for the declared cream time
DLT(i)5	is the symbol for the declared level for deformation under load and temperature at
DS (TH)	is the symbol for the declared level for dimensional stability under specified temperature and humidity
FRB	is the symbol for the declared beaker free-rise density
FRC	is the symbol for the declared core free-rise density
GT	is the symbol for the declared gel time
MU	is the symbol for the declared water vapour diffusion resistance factor
TFT	is the symbol for the declared tack-free time
W	is the symbol for the declared short term water absorption by partial immersion

3.2.3 Abbreviations used in this standard:

PIR is **R**igid **P**oly**I**socyanurate Foam

PU is rigid polyurethane foam including PUR and PIR types

PUR is **R**igid **P**oly**U**rethane Foam

ITT is **I**nitial **T**ype **T**est

4 Requirements

4.1 General

The foam properties shall be assessed in accordance with Clause 5. To conform with this standard, foam systems shall meet the requirements of 4.2 and 4.3 as appropriate.

NOTE The range of properties exhibited by PUR products is very wide. The same is true for PIR products and these two ranges often overlap. Although not in every case, generally PIR products have a higher upper service temperature and can perform better in reaction to fire tests. In all cases, for both PIR and PUR products, their individual performance claimed by the manufacturer are described by the levels of properties obtained. Accordingly, therefore, all the declaration clauses will be completed using the term PU to include both PUR and PIR products (see 3.1.3).

One test result for a foam property is the average of the measured values on the number of test specimens given in Table 7.

4.2 For all applications

4.2.1 Thickness measurements

Unless otherwise specified by the test method, in all the other test methods involving the measurement of thickness, this shall be carried out using the method given in EN 823.

4.2.2 Thermal resistance and thermal conductivity

Thermal resistance and thermal conductivity shall be based upon measurements carried out in accordance with EN 12667 or EN 12939 for thick products.

The thermal resistance and thermal conductivity (both the initial and the aged values) shall be determined in accordance with Annex A, Annex C and 5.3.2 and the aged values declared by the manufacturer according to the following:

— the reference mean temperature shall be 10 °C;

— the measured values shall be expressed with three significant figures;

— the thermal resistance, R_D, shall always be declared. The thermal conductivity, λ_D, shall be declared wherever this is possible;

— the declared thermal resistance, R_D, and the thermal conductivity, λ_D, shall be given as limit values representing at least 90 % of the production, determined with a confidence level of 90 %;

— the value of thermal conductivity, $\lambda_{90/90}$, shall be rounded upwards to the nearest 0,001 W/(m·K) and declared as λ_D in levels with steps of 0,001 W/m·K);

— the declared thermal resistance, R_D, shall be calculated from the nominal thickness, d_N, and the corresponding thermal conductivity, $\lambda_{90/90}$ unless measured directly;

— the value of thermal resistance, $R_{90/90}$, when calculated from the nominal thickness, d_N, and the corresponding thermal conductivity, $\lambda_{90/90}$; shall be rounded downwards to the nearest 0,05 m^2·K/W, and declared as R_D in levels with steps of 0,05 m^2·K/W (see Note);

An example of the determination of the declared aged values of thermal conductivity and thermal resistance is given in Annex I.

NOTE The declaration of the declared installed aged thermal resistance for an installed sprayed rigid PU foam is made in Part 2 of this standard (EN 14315-2) by the installer.

4.2.3 Reaction to fire of the products

4.2.3.1 General

The reaction to fire classification of the products placed on the market shall be determined in accordance with EN 13501-1 and using data obtained from tests carried out according to procedures EN ISO 11925-2 and EN 13823 and utilising test specimens conforming to 4.2.3.2 and mounting and fixing procedures in accordance with 4.2.3.3.

The PUR or PIR product may be qualified as one for which the Reaction to Fire classification is not susceptible to change during production of the system, provided that it can be demonstrated (for example with a production control system) that the characteristics responsible for change are within a range where no change of the declared classification for the product occurs.

4.2.3.2 Test specimens

4.2.3.2.1 EN ISO 11925-2

Cut six test specimens 250 $^{0}_{-1}$ mm long and 90 $^{0}_{-1}$ mm wide and using the product thickness up to a maximum of 60 $^{0}_{-1}$ mm thick including the internal facing in accordance with 5.2 of EN ISO 11925-2:2010 from a sample prepared in accordance with Annex D and complying with the requirements of G.3.1.1.

4.2.3.2.2 EN 13823

Prepare five specimens in accordance with G.3.2.1.

4.2.3.3 Mounting and fixing procedures

4.2.3.3.1 EN ISO 11925-2

Test specimens prepared in accordance with 4.2.3.2.1 shall be mounted in the EN ISO 11925-2 test apparatus as specified in G.3.1.

4.2.3.3.2 EN 13823

Test specimens prepared in accordance with 4.2.3.2.2 shall be mounted so that the inner face of the test specimen which is typical of the end use application is in contact with the flame source. In all other respects, the products shall be mounted as specified in G.3.2.

4.2.3.4 Procedures

4.2.3.4.1 EN ISO 11925-2

Apply the test flame to the natural skin of the test specimen (as specified in G.3.1.1).

4.2.3.4.2 EN 13823

Expose the internal surface of the test specimen to the test flame (see G.3.2.1 and G.3.2.2).

4.2.4 Reaction profile and free-rise density

The appropriate values for the spray foam system shall be stated, having been determined in accordance with the procedures given in Annex E.

4.2.5 Durability characteristics

4.2.5.1 General

The appropriate durability characteristics have been considered and are covered in 4.2.5.2, 4.2.5.3 and 4.2.5.4.

4.2.5.2 Durability of reaction to fire against ageing/degradation

The reaction to fire performance of PU products does not decrease with time, in the applications covered by this standard.

4.2.5.3 Durability of thermal resistance against ageing/degradation

This is covered by 4.2.3, 4.3.12 and Annex C which contains an ageing procedure used to determine the values of the declared thermal resistance.

4.2.5.4 Durability of compression strength against ageing/degradation

The compression strength of PU products remains constant with time if there is no air diffusing into the cells (ageing). If air diffusion is characteristic of the product then the compression strength will increase with time. The higher the closed cells level, the higher the increase of the compression strength with the time, i.e. this increase will be the highest with level CCC4 and least with level CCC1.

4.2.6 Closed cell content

The closed cell content shall be determined using the ISO 4590 method and classified as shown in Table 1.

Table 1 — Classes for closed cell content

Class	Closed cell content
CCC1	< 20 %
CCC2	20 % to 80 %
CCC3	> 80 % to 89 %
CCC4	≥ 90 %

4.3 Specific applications

4.3.1 General

If there is no intended requirement for a property described in 4.3, for a product in the end-use application, then the property need not be determined and declared by the manufacturer.

4.3.2 Water vapour transmission

Water vapour transmission properties shall be determined in accordance with EN 12086, Method A (23 °C, 0/50 % R.H.). The water vapour resistance shall be declared as the water vapour resistance factor, μ, under the symbol MU. No test result shall be lower than the declared value.

4.3.3 Short-term water absorption by partial immersion

The short-term water absorption by partial immersion, W_p, in kg/m^2, shall be determined using EN 1609, Method B and shall be declared in kg/m^2. No test result shall be higher than the declared value.

4.3.4 Compressive stress or compressive strength

Compressive stress at 10 % deformation, σ_{10}, or the compressive strength, σ_m, shall be determined in accordance with EN 826. No test result for either the compressive stress at 10 % deformation, σ_{10}, or the compressive strength, σ_m, whichever is the smaller, shall be lower than the value, given in Table 2, for the declared level.

Table 2 — Levels for compressive stress or compressive strength

Level	Requirement kPa
CS(10\Y)100	≥ 100
CS(10\Y)150	≥ 150
CS(10\Y)200	≥ 200
CS(10\Y)300	≥ 300
CS(10\Y)400	≥ 400
CS(10\Y)500	≥ 500

NOTE For PU products, the effects of pedestrian or stationary traffic can be assessed by means of determination of the compressive stress or compressive strength in accordance with EN 826.

4.3.5 Compressive creep

Compressive creep, ε_{ct}, and total thickness reduction, ε_t, shall be determined after at least 122 days of testing at a declared compressive stress, σ_c, given in steps of at least 1 kPa and the results extrapolated 30 times, corresponding to 10 years, to obtain the declared levels in accordance with EN 1606. Compressive creep shall be declared in levels, i_2, and the total thickness reduction shall be declared in levels i_1, with steps of 0,5 % at the declared stress. No test result shall exceed the declared levels at the declared stress.

NOTE 1 Examples for declaration of levels for compressive creep are given in Table 3.

Table 3 — Levels for compressive creep

Level	Test time	Extrapolation time	Declared stress	Requirement
	days	years	kPa	%
CC(i_1/i_2/10) σ_c	122	10	σ_c	i_1, i_2
CC(i_1/i_2/25) σ_c	304	25	σ_c	i_1, i_2
CC(i_1/i_2/50) σ_c	608	50	σ_c	i_1, i_2

NOTE 2 Referring to the designation code CC(i_1/i_2/y) σ_c, according to Clause 6, a declared level CC(3/2/25)40, for example, indicates a value not exceeding 2 % for compressive creep and 3 % for total thickness reduction after extrapolation at 25 years (i.e. 30 times 304 days of testing) under a declared stress of 40 kPa.

4.3.6 Sound absorption

The sound absorption coefficient shall be determined in accordance with EN ISO 354. The sound absorption characteristics shall be calculated according to EN ISO 11654 with the values for α_p (practical sound absorption coefficient) at the following frequencies: 125 Hz, 250 Hz, 500 Hz, 1 000 Hz, 2 000 Hz and 4 000 Hz and the single number value for α_w (weighted sound absorption coefficient).

α_p and α_w shall be rounded to the nearest 0,05 (α_p larger than 1 shall be expressed as α_p = 1) and declared in levels with steps of 0,05. No test result (α_p and α_w) shall be lower than the declared level.

If the sound absorption is declared, the thickness or the range of thicknesses, in which the declared value is valid, shall be also indicated.

NOTE In any case, the dependence of the sound absorption with the thickness in rigid foam spray systems is very low and only relevant for those with low closed cell contents (CCC1).

4.3.7 Dangerous substances

National regulations on dangerous substances may require verification and declaration on release, and sometimes content, when construction products covered by this standard are placed on those markets.

In the absence of European harmonised test methods, verification and declaration on release/content should be done taking into account national provisions in the place of use.

NOTE An informative database covering European and national provisions on dangerous substances is available at the Construction web site on EUROPA accessed through: *http://ec.europa.eu/enterprise/construction/cpd-ds/*

4.3.8 Substrate adhesion strength perpendicular to faces

This property shall be measured using the procedure given in Annex F. For CCC1 products with closed cell content less than 20 %, the adhesion of the foam to the substrate, σ_a, shall be such that it exceeds the cohesive strength of the foam. For all other products, the bond strength shall not be less than 20 kPa and declared according to the levels given in Table 4.