INTERNATIONAL STANDARD

**ISO 28278-2**

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# Glass in building — Glass products for structural sealant glazing —

## Part 2: Assembly rules

*Verre dans la construction — Produits verriers pour vitrage extérieur collé —*

*Partie 2: Règles de pose*

Reference number
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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 28278-2 was prepared by Technical Committee ISO/TC 160, *Glass in building*, Subcommittee SC 2, *Use considerations*.

ISO 28278 consists of the following parts, under the general title *Glass in building — Glass products for structural sealant glazing*:

— *Part 1: Supported and unsupported monolithic and multiple glazing*

— *Part 2: Assembly rules*

# Introduction

Structural sealant glazing, hereinafter referred to as SSG, is an assembly in which the glass products are fixed to the structural seal frame by means of a sealant.

The sealant must primarily be capable of withstanding the load actions applied to the glass products and transferred to the structural seal frame but can also function as a barrier against the passage of air and water through a building envelope.

Structural sealant glazing can be considered a product. It can also be considered an assembly method for glass into or onto a framework.

In the first consideration, the conditions are to be fulfilled by a manufacturer in order to place a complete structural sealant glazing and structural sealant glazing kit on the market, intended to be sold as one complete product in one (trade) transaction

In the second consideration, the framework, glass products, sealant and accessories, materials and components can be the subject of separate, independent (trade) transactions, independently ordered, and supplied on the construction site or in a workshop where an assembler only assembles the various materials and component elements and subsequently installs the construction, all in accordance with the conditions and under the responsibility of a designer.

Only when the design of a building can be such that the glass products should be installed directly in the building using a structural glazing technique, but under controlled environmental conditions as expressed in Clause 5 of this document, should this part of ISO 28278 apply.

This means that the assembler is only responsible for the assembly, not for the design. Assembly and design are two separate tasks with their own responsibilities.

However, in a number of countries, contractors have the duty to warn architects if there is a view that something in the design is wrong. An analogy would be the case where it is assumed that the assembler has the same duty towards the designer. In order to give the assembler a feeling of what the design considerations are, and at the same time to understand what information he or she requires from the designer, design guidance is given in this part of ISO 28278 in Annex C.

# Glass in building — Glass products for structural sealant glazing —

## Part 2:
## Assembly rules

### 1 Scope

This part of ISO 28278 gives guidelines for the assembly and bonding of glass elements in a frame, window, door or curtain-walling construction, or directly into the building by means of structural bonding of the glass element into or onto the framework or directly into the building.

It gives the assembler information that enable him to organize his work and comply with requirements regarding quality control.

Quality control of the assembly process is of the highest importance. This part of ISO 28278 provides the minimum requirements for acceptable quality control of the process of structural sealant glazing (SSG) on a single project. The annexes contained at the end of this part of ISO 28278 provide the methods to ensure proper application and documentation for a safe and weatherproof glazing assembly product.

This process is intended to be applicable to most SSG projects. The project testing on metal substrates and glass products will determine proper surface preparation and installation instructions.

These rules do not apply to the adhesion or durability of the paint finishes or glass products. This is not intended to be a durability test requirement for the paint and glass products commonly used in the SSG process.

The structural, weatherproofing and sealant products which are commonly used in structural glazing applications are those based on organosiloxane, “silicone” polymers.

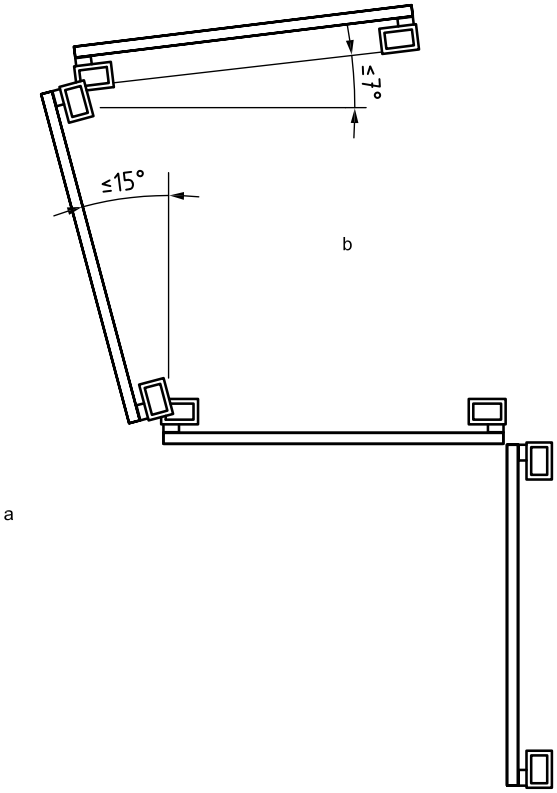
This part of ISO 28278 does not preclude the use of other sealant types, where these can demonstrate suitability for service according to this part of ISO 28278 and when they are used following the recommendations of the sealant manufacturer.

Supports to be taken into consideration shall be only metallic substrates, uncoated glass, coated glass and ceramic frit enamelled glass.

This part of ISO 28278 relates to SSG systems for use in façades and roofs, or parts of them, with glazing with slopes as shown in Figure 1.

Façades with an inclination of less than 15° from the vertical are considered vertical façades.

If the slope to the outer side has an inclination above 50°, the glass is considered unsupported glass.




**Key**

a Outer side.

b Inner side.

**Figure 1 — Slopes and glass positions**

## 2 Normative references

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

ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 8339, *Building construction — Sealants — Determination of tensile properties (Extension to break)*

ISO 11600, *Building construction — Jointing products — Classification and requirements for sealants*

ISO 28278-1:—[1)], *Glass in Building — Glass products for structural sealant glazing — Part 1: Supported and unsupported monolithic and multiple glazing*

ASTM C794, *Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants*

EN 28339, *Building construction. Jointing products. Sealants. Determination of tensile properties*

1) To be published.

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 28278-1 and the following apply.

**3.1**
**structural bonding**
assembly of glass elements into or onto a window, door or curtain-walling framework by means of a structural seal

**3.2**
**structural seal**
joint of elastic structural sealant extruded between glass element or glass and framework which is, when cured, of adequate transverse cross-section to transfer appropriate forces applied on the glass to the structural seal support frame

**3.3**
**structural sealant**
elastic sealant used for making a structural seal

**3.4**
**cohesion failure**
failure occurring in the matter

**3.5**
**adhesive failure**
failure occurring on the bonding surface

**3.6**
**initial cure**
stage in the curing where sealant has appropriate cohesive strength to resist different levels of action

**3.7**
**creep factor**
shear design stress under permanent static load

**3.8**
**type testing**
determination of the performance of a product (characteristic, durability), on the basis of either actual tests or other procedures (such as conventional, standardized, tabulated or general accepted values, standardized or recognized calculation methods, test reports when made available), in accordance with, and demonstrating compliance with, this part of ISO 28278

**3.9**
**test report**
document that covers the results of tests undertaken on a representative sample of the product from production or on a prototype design of the product

**3.10**
**product description**
document that details the relevant parameters for defining a product that complies with the standard

NOTE It includes specific reference(s) to characteristics that are modified by the production process and by raw materials.

**3.11**
**significant change**
variation in performance beyond the permitted tolerance for the characteristic

**3.12**
**glazing assembly manufacturer**
manufacturer who assembles, bonds and seals the different components

# 4 Requirements

## 4.1 Environmental conditions

The assembly of the glass elements into or onto the window, door or curtain-walling framework or directly in the building or construction shall take place under the following controlled environmental conditions:

— the temperature of the surface of the frame and of the glass and of the close environment shall be not less than 5 °C and not more than 40 °C;

— for a given temperature, the %RH value shall be inferior to the value corresponding to the dew point on the support to the seal;

— the environment in the vicinity of the assembly shall be dust-free;

— glass elements stored and installed vertically are securely fixed until the sealant has reached a cure level that meets design requirements.

## 4.2 Conformity of the work with the design

It shall be ensured that the work is executed as foreseen by the design so that, in particular:

— curing of the various seals proceeds as foreseen by the design;

— after curing, the characteristic performances, including durability are deemed to satisfy the design requirements;

— assembled units that meet the design loads at the time of installation are installed on the building;

— a full record of quality control documentation for the entire project shall be maintained;

— the design shall conform to Annex C.

# 5 Assembly/bonding

The assembly manual shall be used for instruction by both the assembly and control personnel and will be a part of the assembly control documentation.

The assembly manual shall make reference to the design of the work and detail the assembly procedures, in particular what is related to:

— the component materials and products, trade name, generic type, marking and labelling;

— the cleaning and preparation materials, trade name, generic type, marking and labelling;

— the installations, equipment and tools for transport, storage, cleaning, use of primers, other preparation work of bonding surfaces, mixing sealant components, extrusion of sealant;

— the cleaning process of the seal bonding surfaces;

— information concerning the compatibility with:

  — various materials and components such as paint finishes, metal coatings, setting blocks, spacers, etc.;

  — cleaning products;

— where applicable, the process for use of primers;

— the positioning of glass and framework before extrusion of sealant, including the application of glazing blocks (see ISO 28278-1), anti-adhesive film and backer rod;

— the extrusion of sealant;

— the waiting time to obtain initial cure and the transport and storage conditions just after initial cure;

— the waiting time to obtain further curing and the final installation of the work;

— the finishing processes such as removal of temporary fixing means and application of weather seals;

— the control of adhesion before achievement.

The assembly manual shall also contain control and testing requirements and conditions, which may be by full description or by reference to this part of ISO 28278.

The designer shall specify that the sealant conforms to Annex B of 28278-1:—[2)].

# 6 Assembly/bonding control

## 6.1 Assembly/bonding control requirements

### 6.1.1 General

An assembler operating under a quality management system such as ISO 9001 or equivalent (when required by an independent laboratory), in which the quality procedures refer to 6.1.3, has the benefit of presumption of compliance with this part of ISO 28278. If not, the following clauses shall be applied.

### 6.1.2 Organization

#### 6.1.2.1 Responsibility and authority

The responsibility, authority and interrelation of all personnel who manage, perform and verify work affecting conformity shall be defined, particularly with regard to personnel who need the organizational freedom and authority to:

a) initiate action to prevent the occurrence of non-conforming assembly;

b) identify and record any assembly non-conformities.

2) To be published.

#### 6.1.2.2 Management representative for assembly control

The glazing assembly manufacturer shall appoint a management representative who, irrespective of other responsibilities, shall have defined authority and responsibility for ensuring that the requirements of this part of ISO 28278 are implemented and maintained.

#### 6.1.2.3 Management review

The assembly control system shall be reviewed at appropriate intervals by the manufacturer's management to ensure its continuing suitability and effectiveness. Records of such reviews shall be maintained so that the assembly process is carried out in accordance with the contract documents.

### 6.1.3 Assembly — Quality assurance system

#### 6.1.3.1 General

The glazing assembly manufacturer shall establish and maintain a documented system as a means of ensuring that the assembly conforms to this part of ISO 28278. The following requirements shall be fulfilled.

#### 6.1.3.2 Personnel

The glazing assembly manufacturer shall appoint personnel for the inspections and assembly control tests that will be carried out before (e.g. incoming materials), during and after assembly.

#### 6.1.3.3 Documentation

The glazing assembly manufacturer's documentation and procedures shall be relevant to the assembly and assembly control, and shall be described adequately in a manual containing the following elements:

a) the objective, responsibilities and authorities of the management with regard to assembly/bonding conformity;

b) the procedures for specifying and verifying the incoming materials (see also the assembly manual);

c) the manufacturing (see the assembly manual), production control and other techniques, processes and systematic actions that will be used;

d) the inspections that will be carried out before production, the inspection tests during and after production, and the frequency with which they will be carried out.

#### 6.1.3.4 Test equipment

The calibration of the test equipment necessary for assembly control shall be documented at the beginning of the project as part of the required documentation and the test equipment shall be calibrated according to the schedule recommended by the test equipment manufacturer.

#### 6.1.3.5 Inspection and testing

Subclause 6.2 designates the inspections and tests by means of tables. The requirements and records are compulsory. The test methods are recommended and therefore only given as information. The frequencies are also recommended and therefore given as information, except when designated otherwise.

Testing and inspection of the glazing assembly process are required so that a full documentation of the project is maintained.

If another testing scheme is used, it shall be described in detail in the quality manual and submitted as part of the contract documents.

Annexes A, B, D, and E and 6.2 describe the tests referred to in this clause as recommendations.

#### 6.1.3.6 Quality contracts

Inspections and tests on incoming materials (the material control section of Table 1) can be reduced on the basis of quality contracts between the supplier and the designer, on condition that the contract refers to the appropriate tables in 6.2.

Quality contracts shall include the possibility of the supplier being audited.

Quality records shall be made available by suppliers for evaluation by the glazing assembly manufacturer representative for all materials supplied on the project.

### 6.2 Inspection and testing tables for assembling glass elements into or onto the framework with structural sealant

The tables consist of three sections:

— section 1: Material control

— section 2: Assembly control

— section 3: Final control

The tables do not pretend to be exhaustive. The designer, assembler, and material suppliers can complete them. The tables can require something that is non-existent in some designs. In such a case, the inspection or test row shall be ignored and in other cases a row shall be added.

When an assembly process is such that one or more of the listed inspections or tests are not applicable or physically not possible, the concerned inspection or test shall be ignored and an alternative shall be determined and documented.

The inspections or tests on incoming materials and component products shall be carried out as soon as possible. In the case of non-conforming materials, action shall be taken so that non-conforming assembly is not performed.

The required records in the tables hereafter can include any document such as order documents, production documents, log books, etc., as described in the quality procedures and associated documentation. However, records shall indicate non delivery or batch identification. When no record is required, this requirement is only valid if there is no negative result. In the case of a negative result, a record shall always be made.

Adjustments of machinery and equipment used for assembly are periodically checked against defined parameters for optimal results.

The assembler shall fulfil the requirements in Clause 4 of this part of ISO 28278.

**Table 1 — Inspection and test table for structural assembly in accordance with ISO 28278-2**

| Section 1: Material control | | | | | |
|---|---|---|---|---|---|
| **Ref.** | **Material, inspection or test** | **Recommended method** (decision to be made by assembler) | **Normative requirement** | **Recommended frequency** (decision to be made by designer or assembler) | **Record normative** |
| **1.1** | **Framework** | | | | |
| 1.1.1 | packaging and label | Visual | See purchase specification | Each delivery | No |
| 1.1.2 | identification | Visual | See purchase specification | Each delivery | Yes |
| **1.2** | **Glass products** | | | | |
| 1.2.1 | packaging and label | Visual | See purchase specification | Each delivery | No |
| 1.2.2 | identification (according to relevant standards) | Visual | See purchase specification | Each delivery | Yes |
| 1.2.3 | dimensions | Measurement | See purchase specification | Each package and thickness | No |
| **1.3** | **Structural sealant** | | | | |
| 1.3.1 | packaging and label | Visual | See purchase specification | Each delivery | No |
| 1.3.2 | shelf-life | Visual | Suppliers' specification | Each delivery | Yes |
| 1.3.3 | **Convenience test**<br>tensile test (when no delivery information[abc] on the sealant or from the sealant supplier is available)<br>adhesion test (may be carried out together or in combination with section 2, line 2.3.1) | Annex A and<br>Annex D<br>Peel and tensile tests | Annex A<br>Failure shall be 90 % cohesive<br>Annex B<br>Strength $\geqslant$ supplier's declared value<br>Minimum breaking value: 0,70 MPa<br>Minimum elongation value: 50 %<br>Rupture: 100 % cohesive | Each delivery of sealant, glass or framework [b] | Yes |
| **1.4** | **Bond-breaker material** | | | | |
| 1.4.1 | packaging and labelling | Visual | See purchase specification | Each delivery | No |
| 1.4.2 | identification | Visual | See purchase specification | Each delivery | Yes |
| **1.5** | **Spacer material** | | | | |
| 1.5.1 | packaging and labelling | Visual | See purchase specification | Each delivery | No |
| 1.5.2 | identification | Visual | See purchase specification | Each delivery | Yes |

**Table 1** (*continued*)

| Section 1: Material control | | | | | |
|---|---|---|---|---|---|
| **Ref.** | **Material, inspection or test** | **Recommended method** (decision to be made by assembler) | **Requirement** | **Recommended frequency** (decision to be made by designer or assembler) | **Record normative** |
| **1.6** | **Weather sealant** | | | | |
| 1.6.1 | packaging and labelling | Visual | See purchase specification | Each delivery | No |
| 1.6.2 | identification | Visual | See purchase specification | Each delivery | Yes |
| **1.7** | **Finishing material** | | | | |
| 1.7.1 | packaging and labelling | Visual | See purchase specification | Each delivery | No |
| 1.7.2 | identification | Visual | See purchase specification | Each delivery | Yes |
| **1.8** | **Retaining devices** | | | | |
| 1.8.1 | packaging and labelling | Visual | See purchase specification | Each delivery | No |
| 1.8.2 | identification | Visual | See purchase specification | Each delivery | Yes |
| **1.9** | **Retaining clips** | | | | |
| 1.9.1 | packaging and labelling | Visual | See purchase specification | Each delivery | No |
| 1.9.2 | identification | Visual | See purchase specification | Each delivery | Yes |
| **1.10** | **Cleaning products** | | | | |
| 1.10.1 | packaging and labelling | Visual | See purchase specification | Each delivery | No |
| 1.10.2 | identification | Visual | See purchase specification | Each delivery | Yes |
| **1.11** | **Primer** | | | | |
| 1.11.1 | packaging and labelling | Visual | See purchase specification | Each delivery | No |
| 1.11.2 | identification | Visual | See purchase specification | Each delivery | Yes |
| **1.12** | **Metal paint finish** | | | | |
| 1.12.1 | hardness | Measurement | | | |
| 1.12.2 | thickness | Measurement | | | |

**Table 1** (*continued*)

| Ref. | Material, inspection or test | Recommended method (decision to be made by assembler) | Requirement | Recommended frequency (decision to be made by designer or assembler) | Record normative |
|---|---|---|---|---|---|
| **Section 1: Material control** | | | | | |
| **1.13** | **Structural sealant** | | | | |
| 1.13.1 | packaging and labelling | Visual | See purchase specification | Each delivery | No |
| 1.13.2 | identification | Visual | See purchase specification | Each delivery | Yes |
| 1.13.3 | shelf-life | Visual | Suppliers' specification | Each delivery | Yes |
| 1.13.4 | **Adhesion control test**<br>(When no delivery information[a] on the sealant or from the sealant supplier is available. May be carried out together or in combination with section 2, line 2.3.1) | | | | |
| 1.13.4.1 | tensile test | Annex B | Annex B<br>Strength $\geqslant$ supplier's declared value<br>Minimum breaking value: 0,70 MPa<br>Minimum elongation value: 50 %<br>Rupture: 100 % cohesive | Beginning of the project | Yes |
| 1.13.4.2 | peel test | Annex A | Annex A | Beginning of the project | Yes |
| 1.13.5 | curing test control for one part | Annex F | See purchase specification | Each delivery | Yes |
| **Section 2: Assembly control** | | | | | |
| **2.1** | **Washing efficiency** | | | | |
| 2.1.1 | dry and clean framework surface | Visual | No visible contamination | Continually | Yes |
| 2.1.2 | dry and clean glass surface | Visual | No visible contamination | Continually | Yes |
| **2.2** | **Structural sealant application** | | | | |
| 2.2.1 | preparation (including application primer) and positioning glass elements or framework | Visual | Assembly manual | Continually | Yes |
| 2.2.2 | extrusion of structural sealant and application retaining clips | Visual | Assembly manual | Continually | Yes |
| 2.2.3 | storage after initial cure | Visual | Assembly manual | Continually | Yes |

**Table 1** (*continued*)

| Ref. | Material, inspection or test | Recommended method (decision to be made by assembler) | Requirement | Recommended frequency (decision to be made by designer or assembler) | Record normative |
|---|---|---|---|---|---|
| **Section 2: Assembly control** | | | | | |
| 2.2.4 | installation on building with retaining devices | Visual | Assembly manual | Continually | Yes |
| 2.2.5 | finishing work | Visual | Assembly manual | Continually | Yes |
| 2.2.6 | application weather sealant | Visual | Assembly manual | Each shift | Yes |
| **2.3** | **Structural sealant** | | | | |
| 2.3.1 | adhesion on relevant substrates[a] | Annex A<br>Peel test (mandatory) and tensile test (optional) | Annex A | (2 × per shift): 2 specimens | Yes |
| 2.3.2 | mixing ratio | See equipment and sealant specifications | See sealant specification | See assembly control manual | Yes |
| 2.3.3 | thoroughness of mixing | Visual | No marbling | Each shift and each start-up | Yes |
| 2.3.4 | air inclusions (during 2.3.3) | Visual | No air inclusions | Together with 2.3.3, each shift, each material change and each start-up | No |
| 2.3.5 | hardness | Hardness test | See sealant specification | Each shift: 2 specimens | Yes |
| 2.3.6 | contamination | Visual | See purchase specification | Each drum | No |
| **Section 3: Final assembly control** | | | | | |
| **3** | **Final assembly** | | | | |
| 3.1 | where applicable, storage conditions | Visual | See assembly control manual | Once per shift | Yes |
| 3.2 | dimensions and positioning of structural seal | Measurement | See design specification | See designer's specification | Yes |
| 3.3 | positioning of glass element versus framework | Measurement | See design specification | See designer's specification | Yes |
| 3.4 | positioning of the retainer devices | Measurement | See design specification | See designer's specification | Yes |
| 3.5 | application of weather seal | Measurement | See design specification | See designer's specification | Yes |

**Table 1** (*concluded*)

| Section 3: Final assembly control | | | | | |
|---|---|---|---|---|---|
| **Ref.** | **Material inspection or test** | **Recommended method** (decision to be made by assembler) | **Requirement** | **Recommended frequency** (decision to be made by designer or assembler) | **Record normative** |
| 3.6 | deglazing of assembled units | Visual and measurement | Ensure full sealant fill and coverage, proper spacer and gasket placement; check frame and glass tolerances | 1 in first 10, 1 in next 40, 1 in next 50 and 1 every 100 thereafter | Yes |
| 3.7 | general aspect of window, door or curtain-walling | Visual | See design specification | Each and every unit | Yes |

[a] Tested samples and results available for one year minimum.

[b] One delivery of anodized aluminium, coated aluminium or stainless steel generally means one day's production (to be specified if different).

[c] One delivery of coated glass means one shipment.

# Annex A
(normative)

# Dynamic peel test on structural sealant

## A.1 General

This test shall be performed on each substrate type involved in the project. The following information is required in order to make the proper surface preparation recommendation for the project.

## A.2 Purpose

This annex gives a method of evaluating the constancy of the cohesive strength of the structural sealant and of the adherence to materials. The description of the test method given below is intended to help sealant suppliers as well as sealant users. Every effort has been made to keep this method as simple as possible without compromising the quality of the manufactured products.

**Table A.1 — Dynamic peel test**

| **Conditioning series for test specimens** (for details, see A.3) | **Peel test** |
|---|---|
| a) Initial, or room temperature conditioning | Yes |
| b) Room temperature water immersion for seven days or 24 h in water at (95 ± 2) °C | |

## A.3 Tests specimens

Production samples of metal and glass products, amongst others, are to be submitted to the sealant manufacturer six weeks before SSG application is to begin. The manufacturer shall test according to D.3 and provide the data along with an interpretation.

## A.4 Peel test

Eight standard test specimens shall be prepared and cured in accordance with D.3.1 and following the sealant manufacturer's recommendations.

## A.5 Conditioning of test specimens

Condition the six standard test specimens for the peel test and ensure that they conform to the selected alternative conditioning. The various conditioning requirements are described in more detail below.

a) Initial, or room temperature conditioning:

Two standard test specimens, according to the sealant manufacturer's recommendations, storage in air at (23 ± 2) °C and (50 ± 5) % relative humidity in accordance with ISO 8339 or EN 28339.

b) Water immersion and room temperature conditioning:

Two standard test specimens, seven days immersion in water at (23 ± 2) °C, subsequently conditioned in air for (24 ± 2) h at (23 ± 2) °C and (50 ± 5) % relative humidity.

c) Hot water immersion and room temperature conditioning:

Two standard test specimens, one day, which is (24 ± 2) h immersed in water at (95 ± 2) °C, subsequently conditioned in air for (24 ± 2) h at (23 ± 2) °C and (50 ± 5) % relative humidity.

## A.6 Test procedure in the case of peel test

All six test specimens shall be subject to the peel test in accordance with D.3.3.

## A.7 Observation

The type of failure shall be 90 % cohesive.

## A.8 Report

The report shall include the following:

— project name;

— test substrate name;

— surface preparation noted for each specimen:

  — the selected alternative possibility;

  — cure condition of each specimen;

  — mode of failure of each specimen;

  — pass or fail of each test specimen;

  — designation and lot number of the sealant;

  — information to identify the glass and framework;

  — test date;

  — any significant observations;

  — surface preparation recommendation based on the data noted above.

# Annex B
(informative)

# Dynamic tensile test on structural sealant

## B.1 General

This test may be performed on each substrate type involved in the project. The following information is mandatory in order to provide the proper surface preparation recommendation for the project.

This annex gives one possible method of evaluating the constancy of the cohesive strength of the structural sealant and of the adherence to materials. The description of the test method given below is intended to help sealant suppliers as well as sealant users. Every effort has been made to keep this method as simple as possible without compromising the quality of the manufactured product.

**Table B.1 — Dynamic tensile test**

| **Conditioning series for test specimens** (for details, see A.2) | **Tensile test** |
|---|---|
| a) Initial, or room temperature conditioning | Yes |
| d) Room temperature water immersion for seven days or 24 h in water at (95 ± 2) °C | |

## B.2 Tests specimens

Production samples of metal and glass products, amongst others, are to be submitted to the sealant manufacturer six weeks before SSG application is to begin. The manufacturer shall test in accordance with a modified ASTM C794 procedure and provide the data along with the interpretation.

## B.3 Tensile test

Six standard test specimens shall be prepared and cured in accordance with D.5.1, and following the sealant manufacturer's recommendations.

## B.4 Conditioning of test specimens

Condition the six standard test specimens for the tensile test and ensure that they conform to the selected alternative conditioning. The various conditioning requirements are described in more detail below.

a) Initial, or room temperature conditioning:

   Two standard test specimens, according to sealant manufacturer's recommendations, storage in air at (23 ± 2) °C and (50 ± 5) % relative humidity in accordance with EN 28339.

b) Water immersion and room temperature conditioning:

   Two standard test specimens, seven days immersion in water of (23 ± 2) °C, subsequently conditioned in air for (24 ± 2) h at (23 ± 2) °C and (50 ± 5) % relative humidity.

c) Hot water immersion and room temperature conditioning:

Two standard test specimens, one day, which is (24 ± 2) h immersion in water of (95 ± 2) °C, subsequently conditioned in air for (24 ± 2) h at (23 ± 2) °C and (50 ± 5) % relative humidity.

## B.5 Test procedure in the case of tensile test

All six test specimens should be subject to tensile rupture with a separation speed of (5 ± 0,5) mm/min at a temperature of (23 ± 2) °C.

## B.6 Observation

The type of failure shall be 90 % cohesive.

The breaking values shall comply with the sealant manufacturer's declaration.

## B.7 Report

The report shall include the following:

— project name;

— test substrate name;

— surface preparation noted for each specimen:

  — the selected alternative possibility;

  — cure condition of each specimen;

  — mode of failure of each specimen;

  — pass or fail of each test specimen;

  — designation and lot number of the sealant;

  — information to identify the glass and framework;

  — test date;

  — any significant observation;

  — surface preparation recommendation based on the data noted above.

# Annex C
(normative)

# Design guidance

## C.1 Characteristics: safety in use

Resistance against actions from wind, snow and self-weight shall be ensured by selecting an appropriate structural sealant. The selected structural sealant shall be provided with:

— a predetermined mechanical resistance, cohesive and adhesive, after curing (refer to C.2);

— the capability of maintaining it's mechanical resistance (durability) under:

  — solar radiation;

  — temperature and humidity variations or cycling;

  — environmental influences, e.g. salt spray and $SO_2$;

  Refer to B.2.4 of ISO 28278-1:—[3] .

— the capability of preventing its degradation and that of the materials it is in contact with, or in close environment with (compatibility). Refer to Annex A.

When there is a risk of earthquake, the sealant design may not be sufficient to resist the loads and complementary arrangements may be necessary.

## C.2 Structural seal dimensions

### C.2.1 Actions

For determination of the wind load, $F$, refer to current (existing) methods of determination of the action, valid for the construction site and the related national application documents (NAD) or other national specifications.

### C.2.2 Mechanical resistance: characteristic ultimate limit-state value

For the characteristic ultimate limit-state value of structural sealant $R_{u;5}$, refer to B.2.3.3 of ISO 28278-1:—[3] and to the sealant supplier's information.

### C.2.3 Calculation model

#### C.2.3.1 Numerical border conditions

Whatever the outcome of the calculations, the following dimensional conditions of the structural seal shall be respected (see Figures C.1 and C.2):

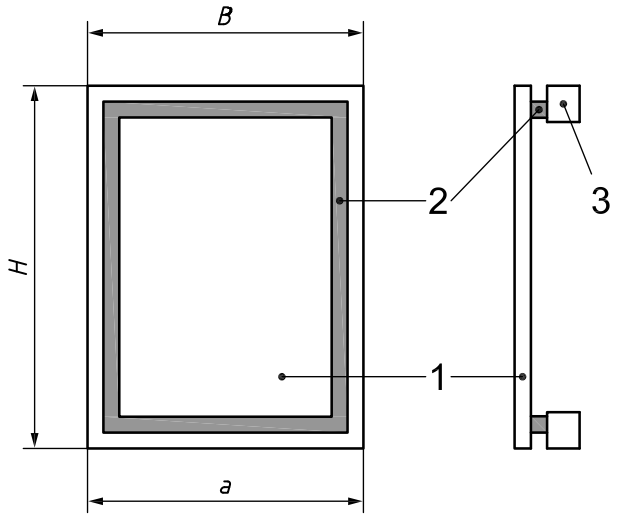
— thickness $e$: minimal $e = 6$ mm, maximal $e = h$;

3) To be published.

— height $h$: $h \geqslant e$ with a minimum of 6 mm; and $h \leqslant 3e$ with a maximum of 20 mm for the monocomponent sealant, 30 mm for the bicomponent and 35 mm in the case of blast-resistant glass;

— distance edge-bonding surface $R \leqslant 40$ mm.

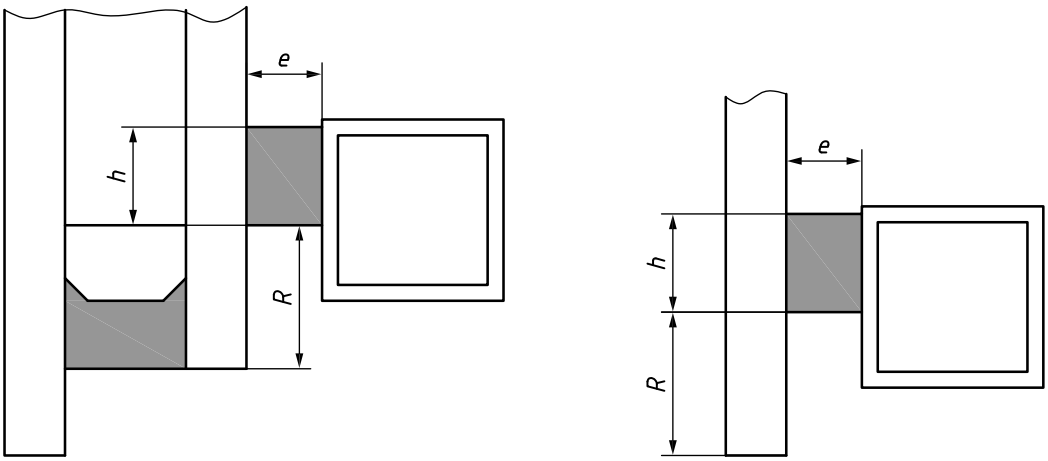
NOTE Higher values can be considered for special conditions/applications (hurricanes, etc.) with the consent of the parties involved.




**Key**

1 glass element
2 structural seal
3 framework
$B$ width or horizontal dimension of the glass element
$H$ height or vertical dimension of the glass element
$a$ smallest dimension (when $H < B$, $a = H$)

**Figure C.1 — Structural element**




**Key**

$e$ structural seal thickness
$h$ structural seal height
$R$ distance edge-bonding surface

**Figure C.2 — Illustrative examples of the structural seal and its position to the glass edge**

### C.2.3.2 Supported systems — Bite thickness, $e$

The load in the plane of the glass surface, derived from temperature differences between glass element and framework, determines the bite thickness. The load generates shear stress in the structural seal. The maximum shear stress is considered to develop in the corners of the pane and, for a rectangular pane, it can be calculated as:

$$f_{\text{shear;s}} = \frac{G\Delta_{\text{s}}}{e} \tag{C.1}$$

where

$e$ is the bite thickness;

$G$ is the shear modulus;

$\Delta_{\text{s}}$ is the shear deformation and is calculated as

$$\Delta_{\text{s}} = \left\{\left(T_{\text{f}} - T_0\right)\alpha_{\text{f}} - \left(T_{\text{g}} - T_0\right)\alpha_{\text{g}}\right\}\sqrt{\left(\frac{B}{2}\right)^2 + H^2} \tag{C.2}$$

where

$B$ is the horizontal dimension of the glass element;

$H$ is the vertical dimension of the glass element;

$T_{\text{f}}$ is the temperature of the framework at moment $t$;

$T_{\text{g}}$ is the temperature of the glass element at moment $t$;

$T_0$ is the temperature during extrusion of the structural sealant;

$\alpha_{\text{f}}$ is the linear elongation coefficient of the framework;

$\alpha_{\text{g}}$ is the linear elongation coefficient of the glass element.

The selected thickness should ensure that

$$f_{\text{shear;s}} \leqslant \frac{R_{\text{shear;}u\text{;5}}}{\gamma_{\text{tot}}} \tag{C.3}$$

where

$R_{\text{shear;}u\text{;5}}$ is the characteristic ultimate limit-state value of the structural sealant;

$\gamma_{\text{tot}}$ is the total factor, which should be set by national rules.

NOTE The use of the high value for the partial factor $\gamma_{\text{tot}}$, together with the inaccurate calculation model, results in structural seal dimensions, which ensure an acceptable safety reliability level as demonstrated by experience over the last 20 years. Lower $\gamma_{\text{M}}$ values could be acceptable when accurate calculation models are used together with an appropriately defined safety reliability level. However, it is doubtful in this case that the structural seal dimensions $h$ and $e$ will be less.

### C.2.3.3 Supported and unsupported systems — Bite height, $h$

The loads perpendicular to the glass surface, derived from wind loads, snow loads, densities, self-weight and impacts, determine the bite height. These loads generate tensile/compression stresses in the structural seal. The maximum tensile stress is considered to develop at the centre of the longest side of the pane, and can be calculated as:

$$f_{\text{tensile}} = \frac{aF}{2h} \tag{C.4}$$

where

$h$ is the bite height;

$a$ is the smallest edge of a rectangular pane;

$F$ is the load to be taken into consideration in accordance with C.2.1.

The selected bite height should ensure that:

$$f_{\text{tensile}} \leqslant \frac{R_{\text{tensile};u;5}}{\gamma_{\text{tot}}} \tag{C.5}$$

where

$R_{\text{tensile};u;5}$ is the characteristic ultimate limit-state value of the structural sealant;

$\gamma_{\text{tot}} = \gamma_{\text{L}} \times \gamma_{\text{S}}$

where

$\gamma_{\text{L}}$ is the factor taking into account the variability of action (see EN 1990:2002, C.9);

$\gamma_{\text{S}}$ is the factor that links to the sealant material;

$\gamma_{\text{tot}}$ is the factor which should be set by national rules.

NOTE In the absence of a national value, $\gamma_{\text{tot}} = 6$, lower $\gamma_{\text{tot}}$ values could be acceptable when accurate calculation models are used together with an appropriately defined safety reliability level.

### C.2.3.4 Unsupported systems — Permanent shear load — Height, $h$

The permanent load in the plane of the glass surface, derived from the self-weight of the glass element determines the bite thickness. This type of load generates permanent shear stress in the structural seal. The maximum permanent shear stress is considered to develop $r$ along the vertical structural seals and, for a rectangular pane, it can be calculated as:

$$f_{\text{perm.shear};u} = \frac{P}{2hH} \tag{C.6}$$

where

$h$ is the bite height;

$H$ is the vertical edge of a rectangular pane;

$P$ is the self-weight of the glass element.

The selected height should ensure that

$$f_{\text{perm.shear};u} \leqslant \Gamma_{\infty} \tag{C.7}$$

where

$\Gamma_{\infty}$ is the declared permanent shear design stress.

### C.2.3.5 Unsupported systems — Permanent shear load — Thickness, $e$

The load in the plane of the glass surface, derived from temperature differences between glass element and framework, determines the bite thickness. The load generates shear stress in the structural seal. The maximum shear stress is considered to develop in the corners of the pane and, for a rectangular pane, it can be calculated as:

$$f_{\text{shear};u} = \frac{G\Delta_u}{e} \tag{C.8}$$

where

$e$ is the bite thickness;

$G$ is the shear modulus;

$\Delta_u$ is the shear deformation and is calculated as

$$\Delta_u = \left\{\left(T_{\text{f}} - T_0\right)\alpha_{\text{f}} - \left(T_{\text{g}} - T_0\right)\alpha_{\text{g}}\right\}\sqrt{\left(\frac{B}{2}\right)^2 + \left(\frac{H}{2}\right)^2} \tag{C.9}$$

where

$B$ is the horizontal dimension of the glass element;

$H$ is the vertical dimension of the glass element;

$T_{\text{f}}$ is the temperature of the framework at moment $t$;

$T_{\text{g}}$ is the temperature of the glass element at moment $t$;

$T_0$ is the temperature during extrusion of the structural sealant;

$\alpha_{\text{f}}$ is the linear elongation coefficient of the framework;

$\alpha_{\text{g}}$ is the linear elongation coefficient of the glass element.

The selected thickness should ensure that

$$f_{\text{shear};u} \leqslant \frac{R_{\text{shear};u;5}}{\gamma_{\text{tot}}} \tag{C.10}$$

where

$R_{shear;u;5}$ is the characteristic ultimate limit-state value of the structural sealant;

$$\gamma_{tot} = \gamma_L \times \gamma_S$$

where

$\gamma_L$ is the factor taking into account the variability of action (see EN 1990:2002, C.9);

$\gamma_S$ is the factor that links to the sealant material;

$\gamma_{tot}$ is the factor which should be set by national rules.

NOTE In the absence of a national value, $\gamma_{tot} = 6$, lower $\gamma_{tot}$ values could be acceptable when accurate calculation models are used together with an appropriately defined safety reliability level.

## C.3 Initial assessment of the design

Materials and components to be used shall be evaluated for the intended uses foreseen by the design and shall conform to the relevant standard.

Any bonding of structural sealant with a substrate shall be tested at least once under the recommendations of the structural sealant manufacturer according to ISO 28278-1:—[4)], Annex I.

Compatibility of materials shall also be tested at least once per project by the structural sealant manufacturer. There shall also be a purchasing requirement by the glazing assembler to have the manufacturer of those accessory materials provide exactly the same materials throughout the project so that testing only need to be done once. Alternative procedures are described in Annex E.

## C.4 Assembly details

In order to ensure that the requirements in Clause 4 are met, the assembler shall prepare information for the designer containing drawings and a list of assembly details, especially when such detailing is not foreseen in this part of ISO 28278.

Particular attention shall be paid to information on:

— the temperature and humidity range at which the sealant may be applied;

— the use of cleaning materials;

— the use of primer;

— the use of temporary retainer clips during curing time;

— the application of retainer devices as part of the design;

— setting block materials and locations;

— storage conditions for the incoming materials;

4) To be published.

— the frequency of adhesion testing and the minimum strength of the adhesion and cohesion;

— compatibility of the various materials and components;

— transportation recommendations.

# Annex D
(normative)

# Adhesion tests in assembly/bonding control

## D.1 General

This annex gives a method for evaluating the strength of bonding to substrates. The description of the methods of measurement and testing given below is intended to help assembly/bonding control. Every effort has been made to keep these methods as simple as possible without compromising the quality of the manufactured products.

## D.2 Purpose

The purpose of the test is to ensure that the structural sealant and the substrates are adequately prepared.

The three tests described below allow the adherence of the sealant to the substrates to be demonstrated for the assembly control scheme:

— peel test;

— static tensile test;

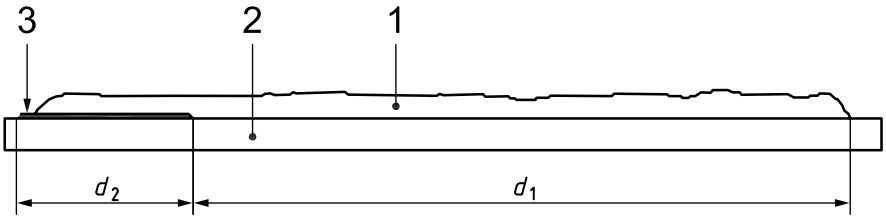
— dynamic tensile test.

## D.3 Peel test — Method 1

### D.3.1 Test specimens

The test specimen shall be prepared in accordance with Figure D.1 in the conditions in which the structural sealant will be applied and subsequently conditioned in the environment in which the complete elements are stored. Primers and cleaners will be used exactly as they are used in production. The sealant sample shall be obtained from the production area.

The curing time shall be in accordance with the sealant supplier's recommendations and documented as part of the quality control procedure.




**Key**

1 structural sealant: approximate width (25 ± 5) mm, minimum height 6 mm
2 substrate with surface representative for delivery
3 bond breaker
$d_1$ minimum 250 mm
$d_2$ (50 ± 10) mm

**Figure D.1 — Illustration of a peel test specimen**

The test specimens shall consist of:

— the structural sealant used in the application;

— a specimen of the glass with a surface representative of the glass delivery onto which the structural sealant will be applied;

— a specimen of the framework with a surface representative of the framework delivery onto which the structural sealant will be applied.

The glass and framework suppliers shall include in each delivery sufficient specimens for the test.

### D.3.2 Curing time

After a minimum curing time in accordance with the sealant supplier's recommendations, the specimen is ready for peeling.

### D.3.3 Test procedure

The bead should be detached from the substrate at one end and manually peeled back at 180° until rupture of the bead occurs. When rupture occurs, the next peeling is initiated by cuts with a knife at the interface of the structural seal substrate or at the other end of the bead.

## D.4 Observation

Breakage shall be 90 % cohesive.

In the event that breakage is not 90 % cohesive, the responsible quality control manager shall be alerted. The specimen shall be tested again with the remaining sample a minimum of 24 h later. Units shall not be erected on site until the issue is resolved.

## D.5 Static tensile test — Method 2

### D.5.1 Test specimens

Four standard test H specimens shall be prepared in accordance with ISO 28278-1:—[5], B.2.3.2, in the conditions in which the structural sealant will be applied and subsequently conditioned in the environment in which the complete elements are stored. The specimens for test shall consist of:

— the structural sealant used in the application;

— the dimensions used in the application or according to ISO 28278-1:—[6], B.2.3.2;

— a specimen of the glass with a surface representative of the glass delivery on which the structural sealant will be applied;

— a specimen of the framework with a surface representative of the framework delivery on which the structural sealant will be applied.

The glass and framework suppliers shall include in each delivery sufficient specimens for the test.

### D.5.2 Curing time

After a minimum curing time in accordance with the sealant supplier's recommendations, the specimen is ready for the static tensile loading.

### D.5.3 Test procedure

The static tensile test shall be performed during the 10 min period in which the sealant is under a stress equal to the declared resistance value at a temperature between 15 °C and 30 °C.

### D.5.4 Observation

During the test or after unloading, no test specimen shall show any signs of breakage or cracking of the sealant or any loss of adhesion.

## D.6 Dynamic tensile test

### D.6.1 Test specimens

Four standard test H specimens shall be prepared in accordance with Annex F, in the conditions in which the structural sealant will be applied and subsequently conditioned in the environment in which the complete elements are stored. The specimens for test should consist of:

— the structural sealant used in the application;

— the dimensions used in the application or according to ISO 28278-1:—[7], B.2.3.2;

— a specimen of the glass with a surface representative of the glass delivery on which the structural sealant will be applied;

---

5) To be published.

6) To be published.

7) To be published.

— a specimen of the framework with a surface representative of the framework delivery on which the structural sealant will be applied.

The glass and framework suppliers shall include in each delivery sufficient specimens for the test.

### D.6.2 Curing time

After a minimum curing time in accordance with the sealant supplier's recommendations, the specimen is ready for the dynamic tensile process.

### D.6.3 Test procedure

For the dynamic tensile test, the test specimen shall be clamped in the tensile equipment. The tensile speed shall be between 5 mm/min and 50 mm/min.

### D.6.4 Observation

As long as the tensile stress is not above the declared resistance value, the test specimen should not show breaks or cracks in the sealant or in the bond. Any breakage in the sealant at increased loads should be cohesive.

## D.7 Report

The report shall indicate the test method and the observations and include:

— pass or fail result of each test specimen;

— designation and lot number of the sealant;

— information to identify the glass and framework;

— test date;

— any deviation from the test described above.

# Annex E
(informative)

# Compatibility with adjacent material

**ALTERNATIVE 1: EN 13022-2, ETAG 002, EN 15434.**

## E.1 Purpose and principle of the test

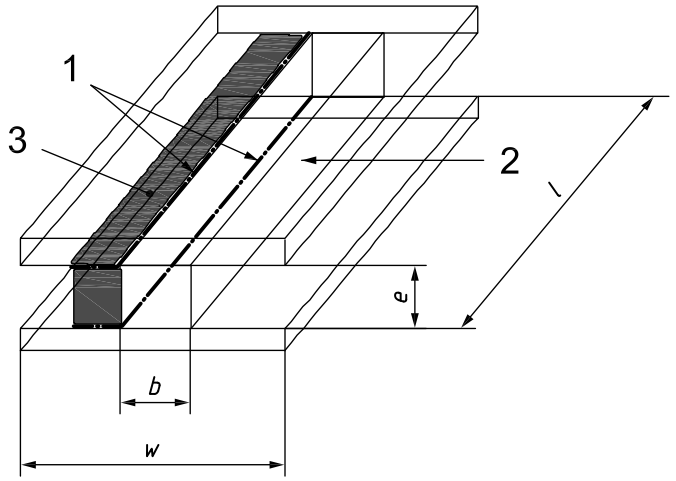
The purpose of this test is to evaluate the incompatibility between the structural sealant and other adjacent materials (such as structural sealant, weather sealant, spacer materials, aluminium and glazing, as well as manufacturing materials, such as preparatory and cleaning products). Incompatibility may be indicated for instance by discoloration.

Two test methods are proposed to verify compatibility, one method without UV and one method with UV. Due consideration must be given to the risk of UV exposure in service. In some cases, it may be necessary to apply both tests.

a) Method without UV

— Test specimens: description, conditioning and number

Seven test pieces are prepared as shown in Figure E.1 and conditioned at a temperature of (60 ± 2) °C and (95 ± 5) % relative humidity. Five pieces are tested for 28 days and the remaining two for 56 days.




**Key**

1 bond breaker
2 structural sealant
3 gasket, sealant, other material

**Figure E.1 — Typical test specimen for compatibility test**

— Testing:

The test samples shall be tested as follows:

— mechanical strength: Five test pieces shall be subjected to the tensile test in accordance with D.3.3 after 28 days of conditioning. The material to be tested for compatibility should be removed before the tensile test so that the results relate only to the bond between the structural sealant and glass and to the structural sealant itself. If the two materials in the samples cannot be separated without damage, it will be necessary to make five additional samples and to test these, as controls, with the secondary material in place and without conditioning.

— effect on colour: Two test pieces shall be examined for discoloration every 14 days throughout the 56-day conditioning period.

— Evaluation:

— $R_{u,5}$ after conditioning $\geqslant$ 0,85 $R_{u,5}$ initial;

— no discoloration permitted.

b) Method with UV

— test specimen description and test procedure.

Five tests pieces are prepared as shown in Figure E.1.

The test specimens shall be conditioned for 28 days at (23 $\pm$ 2) °C and (50 $\pm$ 5) % R.H., or in conformity with the specification of the sealant manufacturer.

Products No 2 and No 3 are sealants whose compatibility with product No 1 is checked.

After 1 to 3 days' cure of the various products, the test pieces are submitted for irradiation using a UV lamp.

— type of lamp: Xenon (ISO 4892-2) or equivalent;

— power: (60 $\pm$ 5) W/m$^2$ measured at the level of the sample, and between 300 nm and 400 nm;

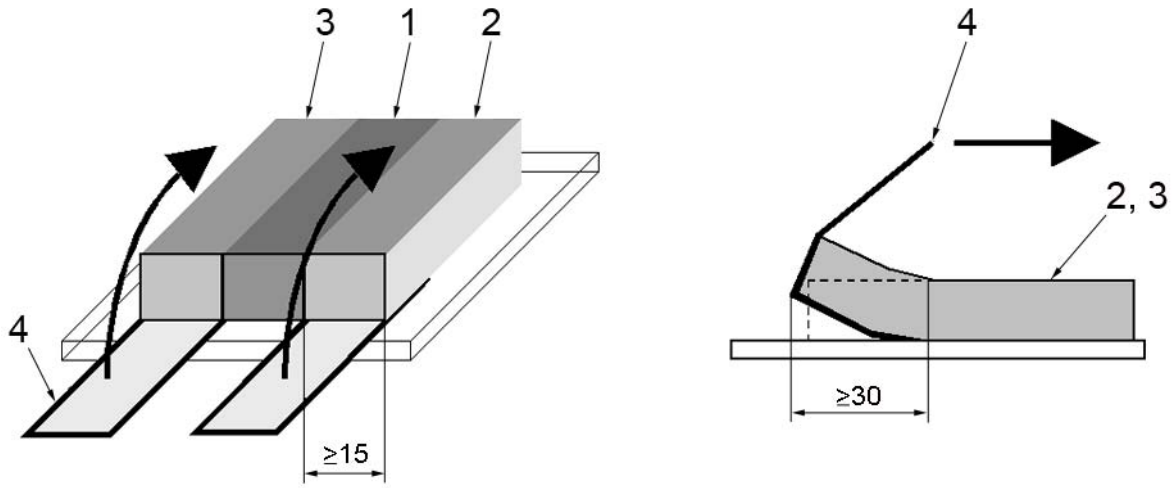
— temperature: (60 $\pm$ 2) °C;

— duration: (504 $\pm$ 4) h.

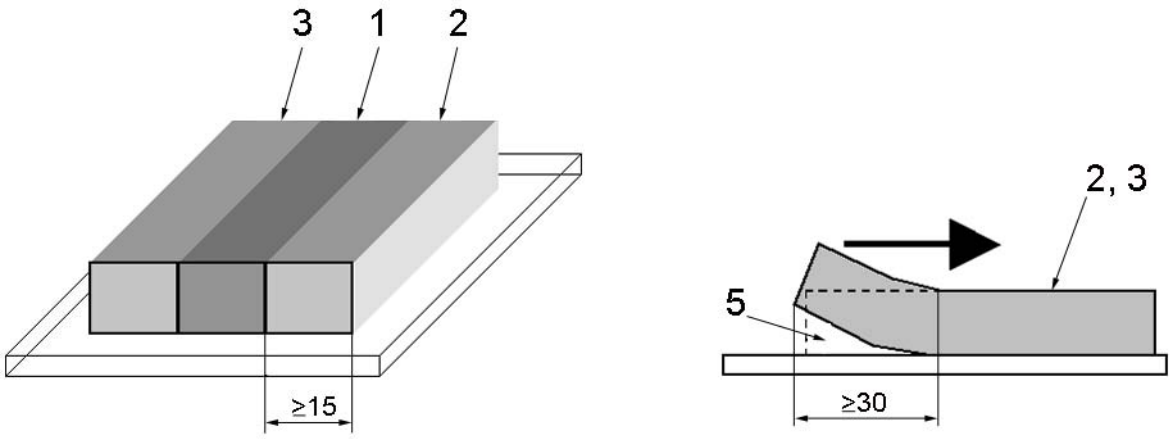
If adhesion has occurred between products No 1 and No 2 or No 1 and No 3, a clean incision shall be made to separate them.

## E.2 Testing method

Dimensions in millietres




**a) Peel test with strips of cloth**




**b) Peel test with incisions**

**Key**

1 product No 1
2 product No 2
3 product No 3
4 strip of cloth
5 incision ⩾ 30 mm

**Figure E.2 — Peel test — Alternative**

— Testing:

  — Peel test with strips of cloth:

    The samples are placed in a tensile test machine and the embedded cloth is peeled back at 180° to the substrate.

  — Peel test with incisions:

    — clean incisions are made at the interface of the substrate and products No 2 and No 3.

- the sealant beads are manually peeled back at 180° to the substrate.
- any signs of staining in the paler-coloured sealant are noted.

— Evaluation:

- no discoloration by visual observation.
- peel test requirement: no adhesive rupture permitted during the peel test.

**ALTERNATIVE 2: See ASTM C1087 TEST METHOD**

# Annex F
(normative)

# Skin-over time/elastomeric test

For one-part sealants, a skin-over and elastomeric test shall be performed once a week and on every new lot of sealant used. The purpose of the test is to check the sealant's working time and to ensure the sealant cures fully. Any great variation (excessively long time period) in the skin-over time may indicate an out-of-shelf-life sealant.

This test shall be performed as follows:

a) Spread a bead of sealant into a 1 mm film on a sheet of polyethylene.

b) Every few minutes, touch the sealant film lightly with a tool.

c) When the sealant does not adhere to the tool, the sealant is said to have skinned over. Note the time required to reach this point. If a skin has not formed within 3 h, do not use this material and contact your sealant supplier representative.

d) Allow the sealant to cure for 24 h. After 24 h, peel the sealant from the polyethylene sheet. Stretch the sealant slowly to see that it has cured. Release the stretch and check to see that it returns to approximately the original length. If the sealant has not cured, contact your sealant supplier representative.

e) Record the results in the project log book. This testing shall be completed and results recorded, retained and available for review upon request.

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