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ETAG 002

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GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL FOR

STRUCTURAL SEALANT GLAZING SYSTEMS (SSGS)

amended October 2001

Part 1: SUPPORTED AND UNSUPPORTED SYSTEMS

EOTA, Kunstlaan 40 Avenue des Arts, B - 1040 Brussels

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1 Preliminaries

1.1 Legal basis

This guideline for European Technical Approval has been established in full compliance with the provisions of the Council Directive 89/106/EC (The Construction Products Directive) and has been established taking into account the following steps :

• issuing of the final mandate by the EC		: 18 April 1996.
• adoption of the Guideline by EOTA (Executive commission)		: 2 June 1998.
• endorsement of the document by the EC	SCC opinion of	: 30 June - 1 July 1998.
	EC letter of	: 24 September 1998.

This document is published by the Member States in their official language or languages according to Art 11.3 of the CPD.

1.2 Status of ETA Guidelines

1.2.1 An ETA is one of the two main types of technical specifications in the sense of the EC Construction Products Directive (89/106/EEC). That means that Member States shall presume the approved products fit for their intended use, ie that they enable works in which they are employed to satisfy the essential requirements during an economically reasonable working life, provided that:

- the works are properly designed and built
- the conformity of the products with the ETA has been properly attested.

1.2.2 An ETA Guideline is a basis for ETAs, that is a basis for technical assessment of the fitness for use for an intended use[1].

ETA Guidelines express the common understanding of the approval bodies of the provisions of the EC Construction Products Directive and of the Interpretative Documents with regard to the products and uses concerned established within the framework of a mandate given by the EC Commission after consulting the EC Standing Committee for Construction.

1.2.3 ETA Guidelines are binding for the issuing of ETAs of the products concerned for an intended use when accepted by the EC Commission after consultation with the EC Standing Committee for Construction and published by the Member States in their official language or languages.

The applicability and the satisfaction of an ETA Guideline for a product and its intended use have to be assessed in a case by case evaluation by an authorised approval body.

Satisfaction of the provisions of an ETA Guideline (examinations, tests and evaluations) leads to a presumption of fitness for use only through this case by case evaluation.

Products which are outside of the scope of an ETA Guideline may be considered where appropriate through the approved procedure without guidelines according to Art. 9.2 of the CPD.

The requirements in ETA Guidelines are set out in terms of objectives and of relevant actions to be taken into account. ETA Guidelines specify values and characteristics, the conformity with which carries the presumption that the requirements set out are satisfied, whenever the state of the art permits to do so. The ETA Guidelines may indicate alternative possibilities for the demonstration of the satisfaction of the requirements.

[1] An ETA Guideline is not in itself a technical specification in the sense of the CPD.

2 Scope

2.1 Scope of Guideline

This Guideline relates to Structural Sealant Glazing Systems (SSGS) for use as facades and roofs, or parts of them, with glazing at any angle between vertical and 7° above horizontal (see Figures 1, 3 and 4). This Part of the Guideline covers the general requirements for system assessment and the specific requirements for supported (types I and II) and unsupported (types III and IV) systems (see Figure 1), where the structural seal adhesion surfaces are glass, either uncoated or with an inorganic coating, and anodised aluminium or stainless steel. Subsequent parts of the document will cover the specific requirements for the assessment of the use of glass with an organic coating (opacifier), the use of aluminium with a coating other than anodising, and the use of thermal breaks in SSG framing systems.

Subsequent Parts of the Guideline are to be used together, as necessary, and with this general document, as indicated.

Structural Sealant Glazing Systems involve the technique of bonding glazing to redistribute loads to the facade structure via a structural sealant and a structural sealant-support frame.

The systems are normally put on the market as a “kit” of components (ref EC Guidance paper C "The treatment of kits and systems under the Construction Products Directive"), giving a designer the choice of components required for a particular facade.

The ETA will give details of the components it covers, to be used in accordance with the ETA holder's design rules and installation guide. Typically, the components will include some manufactured by the ETA holder and some by other manufacturers.

This Guideline covers the aspects of performance of a facade affected by the incorporation of the Structural Sealant Glazing System as shown in Figure 4 and allows for the options possible within the kit. The kit components may include the members required for the facade structure, but these are not covered by this Guideline (members indicated by dashes in Figure 4). They will however need to be taken into account in relation to the pre-conditions given in Chapter 7.

SSGS can be constructed in four different ways, which are described below in Table 1 and shown in Figure 1.

Devices to reduce danger in the event of bond failure may be required by national regulations.

TABLE 1 - SSGS types

<u>Type I</u> : Mechanical transfer of the self weight of the infill to the sealant-support frame and thence to the structure. The structural seal transfers all other actions. Devices are used to reduce danger in the event of a bond failure.

<u>Type II</u> : Mechanical transfer of the self weight of the infill to the sealant-support frame and thence to the structure. The structural seal transfers all other actions and no devices are used to reduce danger in the event of bond failure.

<u>Type III</u> : The structural seal transfers all actions including the self-weight of the infill to the sealant support frame and thence to the structure. Devices are used to reduce danger in the event of a bond failure.

<u>Type IV</u> : The structural seal transfers all actions, including self-weight of the infill to the sealant-support frame and thence to the structure. No devices are used to reduce danger in the event of bond failure.

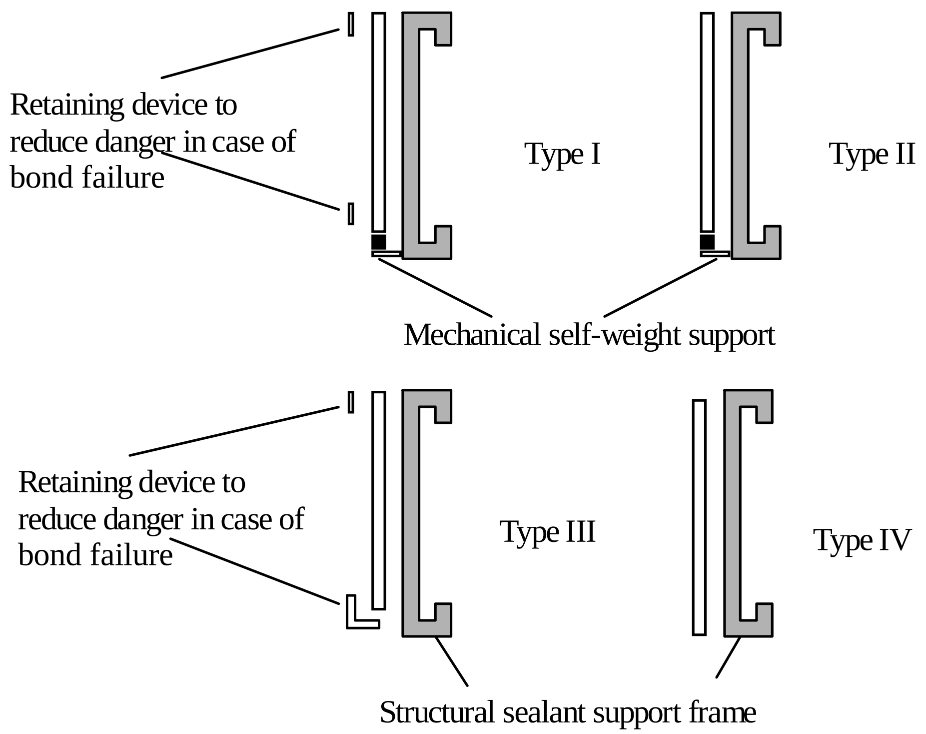


Figure 1 - Schematic examples of the different types of SSGS

Current understanding necessitates a number of general restrictions :

- the structural bond is to be silicone in the form of a linear bead
- the design may include discontinuities in the structural bond, but no edge may be entirely free; some edges may be mechanically beaded
- the structural sealant is to be factory applied.

In due course, further parts of the Guideline may be issued to reduce these limitations.

It is assumed that system designers will follow normal good practice in relation to such matters as glass supply condition (cleanliness, freedom from defects, etc) and application (use of heat-strengthened or laminated glass, etc, as required). These matters are not covered by this Guideline as they are adequately covered by codes and standards. However, there are a number of important requirements with a direct bearing on the design of SSG systems. The following list, though not exhaustive, sets out some of these requirements:

- Machining of glass (for example where required for fitting glazing safety devices) may only be carried out by and/or in agreement with the glass manufacturer.
- Glass shall be selected to ensure it will safely transmit the wind load to the structural sealant support frame via the structural sealant in accordance with national design codes.
- Structural-sealant adhesion on three surfaces is not permissible (see Figure 2). Adhesion to a spacer in an insulating glass unit is not to be considered as a structural bond.

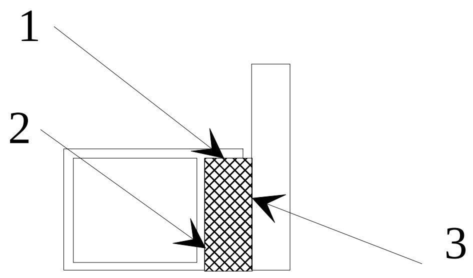


Figure 2 - Structural adhesion on three surfaces - not permissible

- The angle θ shows the range of permissible inclination above 7° (see Figure 3).

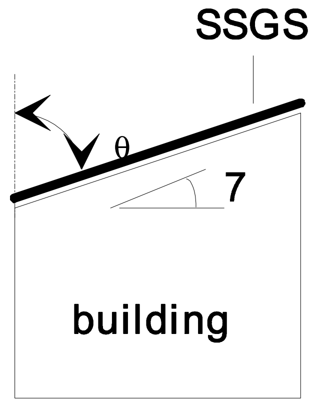


Figure 3 - Permissible inclination

- The present specifications do not apply to a composite system where the interior pane of the IGU is mechanically fastened and the exterior pane is retained by structural sealant.

- The types III and IV SSGS are only applicable for single glass units. For insulating glass units or laminated glass, each pane of glass must be supported (type I or II).

2.2 Use categories

The specification of some SSG systems and the related approach to their assessment necessitates the application of a Use Category in respect of the following aspect of performance.

Use at low temperature

If specified by the manufacturer, systems may be tested at very low temperature (see 5.1.4.1) to assess their suitability for use in cold regions such as, for example, Nordic countries.

3 Terminology

3.1 Common terminology and abbreviations

3.1.1 Works and products

3.1.1.1 Construction works (and parts of works) (often simply referred to as “works”) (ID1.3.1)

Everything that is constructed or results from construction operations and is fixed to the ground. (This covers both building and civil engineering works, and both structural and non structural elements).

3.1.1.2 Construction products (often simply referred to as “products”) (ID 1.3.2)

Products which are produced for incorporation in a permanent manner in the works and placed as such on the market. (The term includes materials, elements, components and prefabricated systems or installations.)

3.1.1.3 Incorporation (of products in works) (ID 1.3.2)

Incorporation of a product in a permanent manner in the works means that:

- its removal reduces the performance capabilities of the works, and
- that the dismantling or the replacement of the product are operations which involve construction activities.

3.1.1.4 Intended use (ID 1.3.4)

Role(s) that the product is intended to play in the fulfilment of the essential requirements.

3.1.1.5 Execution (ETAG-format)

Used in this document to cover all types of incorporation techniques such as installation, assembling, incorporation etc.

3.1.2 Performances

3.1.2.1 Fitness for intended use (of products) (CPD 2.1)

The products have such characteristics that the works in which they are intended to be incorporated, assembled, applied or installed, can, if properly designed and built, satisfy the essential requirements.

(N.B. This definition covers only the intended fitness for intended use as far as relevant for the CPD.)

3.1.2.2 Serviceability (of works)

Ability of the works to fulfil their intended use and in particular the essential requirements relevant for this use.

The products must be suitable for construction works which (as a whole and in their separate parts) are fit for their intended use, subject to normal maintenance, for an economically reasonable working life. The requirements generally concern actions which are foreseeable (CPD Annex I, Preamble).

3.1.2.3 Essential requirements (for works)

Requirements applicable to works, which may influence the technical characteristics of a product, and are set out in objectives in the CPD, Annex I (CPD, art. 3.1).

3.1.2.4 Performance (of works, parts of works or products) (ID 1.3.7)

The quantitative expression (value, grade, class or level) of the behaviour of the works, parts of works or of the products, for an action to which it is subject or which it generates under the intended service conditions (works or parts of works) or intended use conditions (products).

3.1.2.5 Actions (on works or parts of the works) (ID 1.3.6)

Service conditions of the works which may affect the compliance of the works with the essential requirements of the Directive and which are brought about by agents (mechanical, chemical, biological, thermal or electro-mechanical) acting on the works or parts of the works.

3.1.2.6 Classes or levels (for essential requirements and for related product performances) (ID 1.2.1)

A classification of product performance(s) expressed as a range of requirement levels of the works, determined in the ID's or according to the procedure provided for in art. 20.2a of the CPD.

3.1.3 ETAG format

3.1.3.1 Requirements (for works)

Expression and application, in more detail and in terms applicable to the scope of the guideline, of the relevant requirements of the CPD (given concrete form in the ID's and further specified in the mandate), for works or parts of the works, taking into account the durability and serviceability of the works.

3.1.3.2 Methods of verification (for products)

Verification methods used to determine the performance of the products in relation to the requirements for the works (calculations, tests, engineering knowledge, evaluation of site experience, etc.)

3.1.3.3 Specifications (for products)

Transposition of the requirements into precise and measurable (as far as possible and proportional to the importance of the risk) or qualitative terms, related to the products and their intended use.

3.1.4 Working life

3.1.4.1 Working life (of works or parts of the works) (ID 1.3.5(1))
The period of time during which the performance will be maintained at a level compatible with the fulfilment of the essential requirements.

3.1.4.2 Working life (of products)

Period of time during which the performance of the product is maintained - under the corresponding service conditions - at a level compatible with the intended use conditions.

3.1.4.3 Economically reasonable working life (ID 1.3.5(2))

Working life which takes into account all relevant aspects, such as costs of design, construction and use, costs arising from hindrance of use, risks and consequences of failure of the works during its working life and cost of insurance covering these risks, planned partial renewal, costs of inspections, maintenance, care and repair, costs of operation and administration, of disposal and environmental aspects.

3.1.4.4 Maintenance (of works) (ID 1.3.3(1))

A set of preventive and other measures which are applied to the works in order to enable the works to fulfil all its functions during its working life. These measures include cleaning, servicing, repainting, repairing, replacing parts of the works where needed, etc.

3.1.4.5 Normal maintenance (of works) (ID 1.3.3(2))

Maintenance, normally including inspections, which occurs at a time when the cost of the intervention which has to be made is not disproportionate to the value of the part of the work concerned, consequential costs (e.g. exploitation) being taken into account.

3.1.4.6 Durability (of products)

Ability of the product to contribute to the working life of the works by maintaining its performance, under the corresponding service conditions, at a level compatible with the fulfilment of the essential requirements by the works.

3.1.5 Conformity

3.1.5.1 Attestation of conformity (of products)

Provisions and procedures as laid down in the CPD and fixed according to the directive, aiming to ensure that, with acceptable probability, the specified performance of the product is achieved by the ongoing production.

3.1.5.2 Identification (of a product)

Product characteristics and methods for their verification, allowing comparison between a given product and the one described in the technical specification.

3.1.6 Abbreviations

3.1.6.1 Abbreviations concerning the Construction products directive

AC: Attestation of conformity
CEC: Commission of the European Communities
CEN: Comité européen de normalisation (European Committee for Standardization)
CPD: Construction products directive
EC: European communities
EFTA: European free trade association
EN: European Standards
FPC: Factory production control
ID: Interpretative documents of the CPD
ISO: International standardisation organisation
SCC: Standing committee for construction of the EC.

3.1.6.2 Abbreviations concerning approval:

EOTA: European Organisation for Technical Approvals
ETA: European Technical Approval
ETAG: European Technial Approval Guideline
TB: EOTA Technical Board
UEAtc: Union Européenne pour l'Agrément technique (European Union of Agrément).

3.1.6.3 General abbreviations:

IGU: Insulating glass unit
SSGS: Structural Sealant Glazing System
TC: Technical Committee
WG: Working Group.

3.2 Particular terminology:

The terminology is shown in Figure 4 - a vertical section of a supported system. Drainage is not shown.

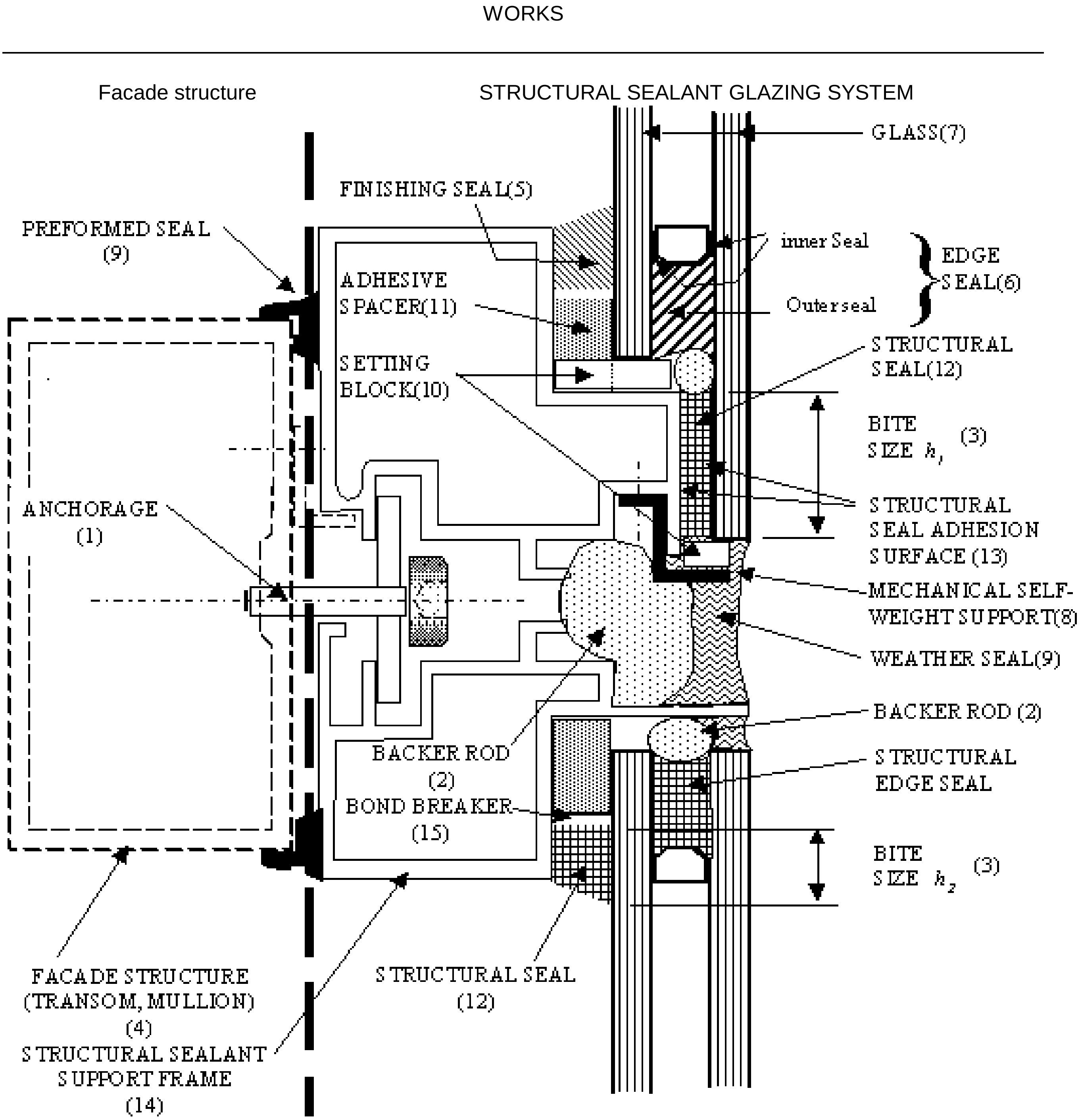


Figure 4 - Structural Sealant Glazing System - vertical section (illustration only for terminology)

Numbers correspond to numbers in Figure 4.

(1) Anchorage

Anchorage of the structural sealant support frame to the facade structure.

(2) Backer rod

Continuous preformed strip limiting the depth of a seal.

(3) Bite

That dimension of the structural seal measured in the plane of a panel. This term refers also to the same dimension of the hermetic seal of an insulating glass unit.

(4) Facade structure

Members to which the structural sealant support frame is connected and which transmit forces to the building.

(5) Finishing seal

As extruded fillet of elastic sealant material of suitable cross-section, which when cured provides an adequate barrier to air and water, or a pre-formed gasket of suitable cross-section.

(6) Hermetic (edge) seal

A means of providing an airtight seal at the perimeter of an insulating unit. It also resists water or vapour ingress, light and ozone whilst remaining compliant to the glass displacements due to wind or other loading. In some system configurations, this seal may have a structural function.

(7) Glass

Glass element consisting of one of the following :

- a single pane (monolithic or laminated)
- an insulating glass unit (IGU) designed for use in SSGS
  There can be two IGU types, the non-stepped IGU, where the two panes have the same nominal dimensions, and stepped IGU, where the two panes of glass are of different dimensions (see Figure 4).

  See also references for CEN standards on glass.

(8) Mechanical self-weight support

Element positioned under the bottom edge of the glazing and transfers the weight of the glazing to the structural sealant support frame.

(9) Weather seal

Fillet of elastic material or a pre-formed gasket of suitable cross-section, providing an adequate barrier to air and water.

(10) Setting blocks

Loadbearing elements between the mechanical self-weight support and a glass bottom edge, to position the glazing unit in the structural sealant support frame.

(11) Adhesive spacer

A continuous preformed strip defining the cross-section of the structural seal and serving to position and align the glass with respect to the structural sealant support frame.

(12) Structural seal

Fillet of elastic sealant extruded in a factory and, when cured, is of sufficient cross-section to adequately transfer the forces between the glass and the structural sealant support frame and between the panes in an insulating unit.

(13) Structural seal adhesion surface

A continuous surface on the glass or on the structural sealant support frame on which the structural sealant adheres.

(14) Structural sealant support frame

Metal element to which the glass is bonded

(15) Bond breaker

A non-adhesive interfacial surface that prevents sealant adhesion

- Complementary terminology (items not shown in figure 4)

(16) Location block

Resilient material between the structural sealant support frame and a glass edge, other than the bottom edge, to position the glazing unit in the structural sealant support frame

(17) Mullion

A vertical frame member supporting the vertical edges of the glass element. It may limit the flexibility of the glass element.

(18) Retaining device

A means of retaining the glass to reduce danger in the event of sealant failure

(19) Transom

A horizontal frame member.

SECTION TWO : GUIDANCE FOR THE ASSESSMENT OF FITNESS FOR USE

4 Requirements (for the works and indication of product-related aspects)

4.0 Preamble

This chapter identifies the aspects of performance to be examined to satisfy the relevant Essential Requirements, by:

- expressing in more detail, and in terms applicable to the scope of the guideline, the relevant Essential Requirements of the CPD (given concrete form in the Interpretative Documents and further specified in the mandate), for works or parts of the works, taking into account the durability and serviceability of the works.

- applying them to the scope of the ETAG (product/system and intended use), and indicating the resulting relevant product characteristics and ultimately other aspects.

4.0.1 Economically reasonable working life

This Guideline is written on the assumption that a working life of 25 years is intended for the system.

All the product specifications and assessment methods derived from Essential Requirements for the works and further requirements for the products shall take account of this assumed working life. The assumed working life of a system cannot be taken as a guarantee given by the producer or the approval body.

All materials used shall exhibit properties or shall be treated to ensure that during the overall working life of the SSGS under normal conditions of use, there is no risk of major deterioration due to internal or external actions such as those from liquid water, water vapour, solar radiation, temperature, etc.

4.0.2 Initial considerations

When deciding upon the ways in which the Essential Requirements bear upon an SSGS, it is necessary for the approval body undertaking the technical assessment to obtain full details of the elements included in the system (kit) and those to be covered by the ETA and, having obtained the details, to decide how to apply the verification methods given in Table 3, to the kit in question. The details of the kit would normally be supplied by the organisation (designer/manufacturer) responsible for placing the SSGS on the market.

The submission shall include, as a minimum, the following details:

(i) The claimed basic levels of performance of the system and any special claims made, particularly in relation to behaviour in fire, acoustic performance or thermal performance.

(ii) The structural sealant type, manufacturer and description.

(iii) The types of glass to be used including the coatings, edge treatment, delivery condition, range of thicknesses, sheet sizes and dimensional tolerances.

(iv) The type of insulating glass unit (detail whether or not the hermetic (edge) seal has a structural function).

(v) The material and coating type for the sealant support frame.

(vi) Details, to include dimensions and materials specification of ancillary components - spacers, setting blocks, backer rods, weathering components, anchorage.

(vii) The type or types of primer to be used to prepare the surfaces and any necessary conditions required for the application.

(viii) The type or types of cleaning product to be used on the complete facade.

(ix) The calculation method used in determining the required dimensions of the structural sealant in particular applications.

(x) Drawings of the assembled system to show detailing including sealing and drainage arrangements, mechanical fixings of the sealant support frame, the arrangement of retaining devices, details of infill and the arrangements for opening lights (if relevant).

(xi) For kits allowing for opening lights, the design and supplier details for all hardware used.

(xii) A copy of the Applicant's site installation instructions.

The declared range of components and materials, in general, should be used when test samples are prepared. Some concessions are permissible in relation to this requirement and these are stated in chapter 5.

4.0.3 Relation between the Essential Requirements and the product characteristics

The relationship between the performance of the kit and its elements, the Essential Requirements of the Construction Products Directive and the Interpretative Documents is given in Table 2. The table also indicates the relationship between the performance characteristics of the mandate and those used for the assessment of the kit and its components. The Table is to be used in the preparation of a test programme for a kit or components.

4.1 ER1 Mechanical resistance and stability

This Essential requirement is not relevant to SSGS.

4.2 ER2 Safety in case of fire

Requirements for the reaction to fire and the resistance to fire of the SSGS shall be in accordance with laws, regulations and administrative provisions, applicable to the end use of the SSGS and will be specified via the CEN classification documents.

4.3 ER3 Hygiene, health and environment

The construction works shall be designed and built such that there will be no threat to the hygiene or health of the occupants or neighbours. For facades incorporating SSGS the following aspects shall be considered:

4.3.1 Air permeability

4.3.2. Release of dangerous substances

The product/kit must be such that, when installed according to the appropriate provisions of the Member States, it allows for the satisfaction of the ER3 of the CPD as expressed by the national provisions of the Member States and in particular does not cause harmful emission of toxic gases, dangerous particles or radiation to the indoor environment nor contamination of the outdoor environment (air, soil or water).

4.3.3 Dampness

4.4 ER4 Safety in use

SSGS facades shall be stable under the combined stresses generated by self-weight, wind load, temperature, moisture, imposed loads, impact, movement of the structure, and snow and ice loads when applicable.

The actions are :

4.4.1 Gravity

Self-weight : Systems of types I and II shall be equipped with a mechanical means of supporting the weight of the glass so that the structural sealant is not required to carry this load. The bearing capacity of this mechanical device shall be determined. In unsupported systems (where there is no mechanical self-weight support), the bearing capacity of the structural seal under long-term shear loading shall be determined.

4.4.2 Effect of the wind and snow load

The system, taking into account (an) appropriate safety factor(s), shall exhibit mechanical resistance to the stresses due to pressure from snowloads and pressure, suction and vibrations caused by the wind.

Any retaining device used shall be designed to retain the glass temporarily should the structural sealant fail.

4.4.3 Effects of building movements

Building movements for example can result from :

- loading in use (wind, temperature, traffic load ...)
- differential deformation between members of the building structure
- differential settlement of foundations
- vibrations.

Any building movements occurring due to one of these causes shall be accommodated by design features in the facade.

It is essential to protect the structural seal from stresses resulting from building movements.

4.4.4 Effect of temperature and barometric pressure

4.4.4.1 Effect of temperature

Extremes of temperatures shall not destroy or irreversibly deform the components of the SSGS.

For practical purposes surface temperatures of - 20°C and 80°C are generally regarded as the limits of temperature range.

For local climatic conditions temperatures outside these limits can be considered (e.g. in nordic countries a temperature of -40°C can be applicable).
The thermal movement of the glass and the structural sealant support frame shall be calculated, for the case in question, generally for a temperature range : (for symbols, see Annex 2)

In summer conditions $\Delta T = T_v - T_c = +25$ K
In winter conditions $\Delta T = T_v - T_c = -25$ K

However:

- Where the sealant support frame is in contact with the external environment around its entire perimeter, it is advisable to undertake a calculation in which $T_v = T_c = 80$ °C as this could represent the most severe conditions.

- In some situations (e.g. special glass, local external conditions etc), ΔT can be modified,

  For example:
  - transparent glazing : maximum temperature T_v=80°C
  - opaque glazing : maximum temperature T_v=100°C.

  The type of glazing shall be suitable and heat accumulation avoided to ensure that excessive temperature variations will not lead to any breakage of the glass.

4.4.4.2 Barometric pressure

It shall be ensured that the barometric pressure differences between the fabrication site and construction site will not adversely affect the durability of the system or any of its components.

T A B L E 2 - Relationship between the performance of the kit, its elements and the Essential Requirements

ER	ID #	ID clause for the works	element involved*	performance of the element (with reference to the ID)	characteristics specified in the mandate	corresponding characteristics in the WP	test or evaluation method
2	2	4.2.3.4 Limitation of the spread of fire and smoke beyond the room of origin	K	4.3.1.3.5.2 Facades, external walls fire resistance performance and fire propagation aspects for external walls including glazing elements	resistance to fire	resistance to fire	Testing determined by the CEN classification document
		4.2.4 Limitation of the spread of the fire to neighbouring construction works	K	"		"	Testing determined by the CEN classification document
		4.2.5 Evacuation of occupants	G	4.3.1.1 Products subject to reaction to fire requirements	reaction to fire	reaction to fire	Testing determined by the CEN classification document
3	3	3.3.1.1 Indoor environment - Air quality	K	3.3.1.1.2 - Control of pollutants	water tightness	chemical composition of kit elements	check - list of dangerous substances
		3.3.1.2 Indoor environment - Dampness	K	3.3.2.2 - Control of dampness		tightness of the system	air, water test of the system - moisture presence also ER6 re thermal characteristics
4	4	3.3.2 Direct impacts 3.3.2.1 Description of the risk - Impacts of falling objects, Forming part of the works, upon users	S	3.3.2.3 Essential characteristics of the products prevention of falling glazed element or piece of glass	bond strength	mechanical resistance and stability	identification of the structural sealant physical and mechanical properties
			SF	"		"	identification of structural sealant support frame
			G	"		"	identification of glazing
			S+SF+G	"		"	mechanical properties of the coupling S + SF + G in the new state and after conditioning and ageing
			D	"		"	mechanical test of devices
			K	Prevention of falling of glazed element when operating the moving parts		"	fatigue test on openable part
			K	Mechanical resistance and stability	wind and snow load resistance	"	wind resistance test
			K	Prevention of falling of glazed element from an unsupported system		"	creep under long-term shear and cyclic tensile loading
			K	Prevention of falling of glazed element under fire (adhesion at high temperature)		safe breakage	adapted fire resistance test (smouldering curve)
			G	Prevention of falling of glazed element / pieces of glass under thermal shock	thermal shock	safe breakage	identification of glass (fragmentation)
		3.3.2.2 Performance of the works - behaviour on impact	K	Prevention of falling of glazed element / pieces of glass under impact		mechanical resistance stability and safe breakage	impact test
		3.3.1.2 Falling due to changes in level	K	3.3.1.3 Falling due to changes in level	sill height	sill height	definition of geometry
5	5	5.2.3.1 Protection against airborne noise from outside of the works	K	4.3.2 Acoustic properties and their expression Acoustic performance of the system	airborne sound insulation	acoustic insulation	airborne sound insulation
6	6	6.3.2.2 Space heating, space cooling and humidity control	S	4.3.2 Characteristics of products which may be relevant to the ER The system and its components must be designed in order to limit the amount of energy required for heating and cooling	thermal resistance	thermal insulation	determination of the steady state thermal transmission properties
		3.2.4 Ventilation			air permeability	tightness of the system	air, water test of the system

* K = kit, SF = structural seal support frame, G = glass, S = sealant, D = devices (self- weight support, retaining devices, anchorage of the support frame on the facade structure).

4.4.5 Effect of water

In addition to the normal practice of drainage, the SSGS shall be designed to keep the structural sealant free from stagnant water. The facade shall be designed to prevent water from collecting in the vicinity of the structural bond.

4.4.6 Accidental actions

The design of the structural seal and the specification of the components (e.g. IGU) shall, where necessary, allow for accidental actions such as falling objects, human impact or static human loads.

4.4.7 Sill height

Minimum sill heights are defined in some national regulations.

4.5 ER5 Protection against noise

The construction works shall be designed and built in such a way that noise transmitted through the SSGS facade from outside is kept down to a level that will not threaten the health of occupants and will allow them to sleep, rest and work in satisfactory conditions.

The acoustic performance of the facade depends to an important extent upon the glazing and when necessary should be designed with the requirements of the project in mind.
The action of the structural sealant as a sound break may be taken into account.

Flanking airborne sound insulation shall where necessary be determined for the works in which the kit is to be incorporated.

4.6 ER6 Energy economy and heat retention

The construction works shall be designed and built in such a way that the thermal transmission coefficient of the facade including the SSGS is in accordance with the relevant national standard or the national regulation for intended use.

4.6.1 Thermal insulation
4.6.2 Air permeability

4.7 Durability

The action of water, temperature, ultraviolet light and other aspects affecting overall durability have been considered under previous headings.

4.8 Accessories and ancillary products

The accessories normally encountered in SSGS are the backer rod, setting blocks, gasket weather seal, weather sealant and spacer. This list is not exhaustive.

The fitness for use of these accessories and ancillary products shall be demonstrated for the particular use in the system, notably :

- spacer : the permeability to water vapour and to structural-sealant solvent shall be sufficient to allow cross-linking (curing) at the core of the structural sealant, regardless of whether the latter is a single-component or two component type. The spacer shall be chemically compatible with its environment and particularly with the structural sealant (test clause 5.1.4.2.5).

- backer rod : the backer rod shall be chemically compatible with its environment and particularly with the structural sealant (test clause 5.1.4.2.5).

- setting block : the setting block shall have the adequate hardness, to support the glazing without damage (Shore D hardness : 70), and be durable and chemically compatible with its environment (test clause 5.1.4.2.5).

- weather sealant : the weather sealant is used on the exterior to seal the joint between the glazed elements and as a finishing seal to protect the rebate against cleaning and condensation water. The sealant shall be durable and fit for use in the SSG system. For example, this can be demonstrated by compliance with ISO 11600. The weather sealant shall be chemically compatible with its environment and particularly with the structural sealant (test clause 5.1.4.2.5). Low modulus sealants (type G-LM to ISO 11600) are advisable in this application.

- gasket weather seal: the gasket is used on the exterior to seal the joint between the glazed elements and as a finishing seal to protect the rebate against cleaning and condensation water. The gasket shall be durable and fit for use in the SSG system. For example, this can be demonstrated by compliance with prEN 12365. The weather gasket shall be chemically compatible with its environment and particularly with the structural sealant (test clause 5.1.4.2.5).

- finishing seal: the finishing seal is used on the interior to seal the joint between the glazed elements and the structural sealant support frames to protect the rebate from surface cleaning water and condensation. The sealant must be durable and fit for use in the SSG system. Where an extruded sealant is used, a low modulus type is advised. The finishing seal shall be chemically compatible with its environment and particularly with the structural sealant (test clause 5.1.4.2.5).

To assess the fitness for use of these ancillaries, the approval body may make use of information derived from documented sources, such as listed experience, previous approval procedures, references to standards, etc.
The specific suitability of the components in the kit can only be demonstrated by compliance with the relevant parts of the chapter 5.

4.9 Verifications necessary in case of interchange of components or suppliers

The components and materials of an SSG kit may be specified in one of two ways, by reference to :

(i) particular manufactured products, using brand names, part numbers, etc.
(ii) generic specifications such as harmonised European Standards.

Any kit is likely to include both types of specification , taking account of the various components. It is likely that during the lifetime of an ETA, the holder will wish to change the specifications and/or supplier of some components.

Interchanging of a component and/or supplier is to be reported by the approval holder to the approval body issuing the ETA, and to the approved body responsible for Attestation of Conformity. It is the responsibility of the approval body to ensure the adequacy of the components and reference to their specification is to be included in the ETA.

Where a component has been specified in terms of a particular manufacturer’s product or where a generic specification does not fully cover the fitness of a component for use in SSGS any change can only be approved by the approval body issuing the ETA, on completion of such testing as is deemed necessary.

Generally, in such cases the issuing of a modified ETA will be necessary, with the consequent amendment of the instructions to the approved body.

Where a component of an SSG kit is specified generically and the approval body has confirmed, in the ETA, the full adequacy of that specification, to confirm the fitness for use of the component in the SSG kit, then a change of supplier will be acceptable. The approved body checks documentation as deemed necessary by the approval body issuing the ETA. In case of doubt reference shall be made to the approval body.

5 Methods of verification

5.0 Preamble

Chapter 5 refers to the verification methods used to determine the various aspects of performance of the products in relation to the requirements for the works (calculations, tests, engineering knowledge, site experience, etc).

The tests in this section are designed to identify the structural sealant, to examine the suitability of the structural adhesion surfaces and to verify the performance of the SSGS in relation to the Essential Requirements. There are limitations on the extent to which the latter aspect can be evaluated without knowledge of the design of particular buildings.

Table 3 lists the tests used to verify the performance of the system components and the system as a whole in relation to the Essential Requirements. Many of the tests are used to verify more than one aspect, or subdivision, of an Essential Requirement. It is not possible, therefore, to write down the methods of verification in the same order as the sub divisions of the Essential Requirements.

A number of tests make reference to non-CEN standards. When an appropriate harmonised CEN standard becomes available, it may replace the standard currently quoted and the part of the Guideline concerned.

The claimed levels of system performance shall be declared to the approval body by the organisation (manufacturer or designer) responsible for putting the kit on the market. These claims then will be investigated by the approval body and a judgement made of the system adequacy.

Where tests are to be carried out on a complete system, the approval body shall ensure that sufficient tests are undertaken to fully examine the system details as proposed by the applicant.
This will depend on the complexity of the system and the number of design options it allows for. The tests, particulary those under ER4 Safety in Use, take into account this possible complexity.

The fitness for use of the insulating glass units (IGU), whether or not the hermetic seal has a structural function shall be demonstrated in accordance with, for example, the UEAtc Guideline *Directive for the Approval of Insulating Glazing* or prEN 1279. The sealant used as the second barrier of the IGU must be UV resistant and chemically compatible with its environment (test clause 5.1.4.2.5). When this second barrier has a structural function, the sealant used is considered as a structural sealant and shall meet all the relevant requirements of Chapter 5 of this Guideline. The minimum thickness of the outer-seal of a structural hermetic seal is normally 6 mm.
All the test methods given relate to supported systems with the exception of the long-term creep test which is an additional test relevant only for unsupported systems in which there will be no mechanical self-weight support to consider.

5.1 Verification methods related to the Essential Requirements

5.1.1 ER1 Mechanical resistance and stability

This requirement is not relevant to SSGS (see ER4 Safety in Use).

5.1.2 ER2 Safety in case of fire

Although the fire performance of a façade is governed by its design (e.g. the use of fire resistant glazing, etc.) and that of the whole building (e.g. incorporation of concrete walls, external gangways, etc.) and may thus vary from building to building using the same SSGS, some characteristics can be determined for the SSGS as such, with the following assessment methods.

5.1.2.1 Reaction to fire

SSG elements contain various components. Reaction to fire performance can only be evaluated for the individual components. This evaluation shall be undertaken in end use conditions.

T A B L E 3 - Verification of performance

	Reference (see Annex 3)	term (1)	element involved (2)
5.1.1 Mechanical resistance and stability	-		N/A
5.1.2 Safety in case of fire			
5.1.2.1 Reaction to fire	CEN classification docs		K
5.1.2.2 Resistance to fire	CEN classification docs		
5.1.3 Hygiene,Health and the Environment			
5.1.3.1 Performance Air Water of SSG elements	PrEN 12153/ prEN 12155		K
5.1.3.2 Air quality and dangerous substances	Check EU + national reg. (e.g. EU database)		
5.1.3.3 Dampness	-	-	K
5.1.4 Safety in use			
5.1.4.1 Initial Mechanical Strength	EN 28-339	ST	S ,G, SF
5.1.4.1.1 Tension rupture and stiffness	EN 28-339	ST	S ,G, SF
5.1.4.1.2 Shear rupture			
5.1.4.2 Residual Mechanical strength after artificial ageing			
5.1.4.2.1 Immersion in water at high temperature	ISO DIS 11431:1991	LT	S ,G, SF
5.1.4.2.2 Humidity and NaCl	ISO 9227	ST	S ,G, SF
5.1.4.2.3 Humidity and SO_2	ISO3231	ST	S ,G, SF
5.1.4.2.4 Facade cleaning products	UEAtc[1]	ST	S,G,SF
5.1.4.2.5 Effects of materials in contact	-	LT	K
5.1.4.3 Mechanical devices			
5.1.4.3.1 Test on the mechanical self-weight support	-	ST	D
5.1.4.3.2 Test on the anchorage of the sealant support frame to the facade structure	-	ST	D
5.1.4.3.3 Test on retaining devices	-	ST	D
5.1.4.4 Tests on openable parts	UEAtc [2]	-	K
5.1.4.5 Impact tests	UEAtc[3]	-	S
5.1.4.6 Structural Sealant			
5.1.4.6.1 Gas inclusion	UEAtc [1]	LT	S
5.1.4.6.2 Elastic recovery	EN 27-389	LT	S
5.1.4.6.3 Shrinkage	ISO/DIS 10563	ST	S
5.1.4.6.4 Resistance to tearing	EAtc[1]	ST	S
5.1.4.6.5 Mechanical fatigue	UEAtc[1]	LT	S
5.1.4.6.6 UV resistance	EN ISO 527	ST	S
5.1.4.6.7 Elastic modulus	EN ISO 527	LT	S
5.1.4.6.8 Creep under long term shear and cyclic tensile loading	-	LT	S
5.1.4.7 Method of calculation of structural seal dimensions		-	
5.1.4.8 Sill height	-	-	K
5.1.4.9 Wind resistance test	UEAtc[2]	ST	K
5.1.4.10 Behaviour in fire	-	-	K
5.1.5 Protection against noise		ST	K
	prEN 12412+ prEN ISO 10077-2		
5.1.6 Energy economy and heat retention	prEN 12153		
5.1.6.1 Thermal insulation	-	ST	K
5.1.6.2 Air permeability		ST	K
5.1.7 Durability aspects		-	-
5.2 Verification methods related to the identification of the products	ISO 1183		
5.2.1 Structural sealant	ISO 868		
5.2.1.1 Specific mass	ISO 7111	ST	S
5.2.1.2 Hardness	ISO 4660	ST	S
5.2.1.3 Thermogravimetric analysis		ST	S
5.2.1.4 Colour	EN 573-3	ST	S
5.2.2 Anodized aluminium structural adhesion surface	-		
5.2.2.1 Alloy of aluminium	ISO 2360/2128/1463/2106	-	-
5.2.2.2 Characteristics of the anodization	ISO 2143 /ISO 3210	-	-
5.2.2.2.1 Measurement of the thickness	ISO 2931	ST	SF
5.2.2.2.2 Sealing test		ST	SF
5.2.2.2.3 Measurement of the admittance	-	ST	SF
5.2.2.3 Description of the process	-		
5.2.2.3.1 Scouring	-	-	SF
5.2.2.3.2 Anodization	EN and prEN	-	SF
5.2.2.3.3 Sealing of the anodized layer	EN 10088	-	SF
5.2.3 Glass and coated glass		-	G
5.2.4 Stainless steel structural adhesion surface		-	SF

(1) ST : short-term or initial state, LT : long-term or aged state. (2) K = kit, SF = structural seal support frame, G = glass, S = sealant, D = devices (mechanical self weight support, retaining devices, anchorage of the support frame on the facade structure)

The performance criteria to be taken into account for reaction to fire are: rate of heat release, rate of flame spread, smoke production, flaming droplets and/or particles (ID 2, clause 4.3.11 and EC decision 2000/147/EC).

- The glazing, where it is glass, uncoated and unlaminated, is to be considered as a class A_1 product, according to the EC decision 2000/ 605/EC and need not be tested under the conditions specified in this document.
- Glazing, provided with organic coatings and/or organic laminated layers shall be tested and classified according the EC decision 2000/147/EC. It is unlikely that such products can obtain a class A_1 rating.
- In exceptional cases regulations will impose reaction to fire classification requirements for sealants. If so, sealants shall be tested in end use conditions and classified according to EC decision 2000/147/EC. It is unlikely that sealants can obtain a class A_1 rating.

The reaction to fire of the fixing devices is irrelevant as they are very small and localised parts.

5.1.2.2 Resistance to fire

Usually, manufacturers of SSG kits will claim no resistance to fire for their products, since this resistance is predominantly determined by the absence of fire resistance of the glazing.

However, where special glazing is used for which resistance to fire is claimed, a test can be undertaken with a specimen comprising a minimum of one in-fill bonded to the sealant support frame, taking into account the considerations of prEN 1363, part 1 (General requirements) and part 2 (Alternative and additional procedures) and prEN 1364-3 (Curtain walling).

See also 5.1.4.10 Behaviour in fire.

5.1.3 ER3 Hygiene, Health and the environment

5.1.3.1 Performance in relation to air permeability, watertightness, wind resistance

The assessment of air permeability and watertightness may require the application of wind load to the sample as a conditioning process; the wind load test procedure therefore is included here for convenience. The structural effects of wind loading are relevant to ER4 'Safety in use' and reference to the deflection under load is to be included in the ETA.

The purpose of these tests is to determine, by using the components of the defined SSGS, whether it is possible to build a facade fit for purpose in relation to air permeability, watertightness and wind resistance . Exceptionally, systems may be offered for use only where air permeability and watertightness are not claimed (building entrances, covered gangways, etc). In such cases tests need not be undertaken.

5.1.3.1.1 Test assembly

The test assembly should fully represent the system. For example, it should include an opening light where these are allowed for in the system and be designed so that at least one of the elements has the largest surface area for which the drainage arrangements are designed. Tests on a number of separate assemblies or modifications to the original assembly can be necessary to include all the declared options, such as inside corners, outside corners and areas of non-vertical glazing. Where the use of single - or double - glazing is permissible and the weather sealing details vary as a result, these options shall also be tested.

The supporting structure shall be designed by conventional calculation not to exceed the maximum deflection allowable for the system at the maximum envisaged wind load.

The sample shown in Figure 5 is only an example of the possible configurations and, in this case is as given by ISO 7895.

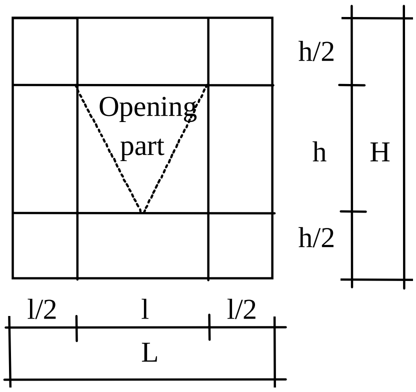


Figure 5 - Example of test assembly

5.1.3.1.2 Air permeability

This test shall be carried out in accordance with prEN 12153 — Curtain Walling — Air permeability — Test method

5.1.3.1.3 Watertightness under static pressure

This test is to be carried out in accordance with prEN 12155 — Curtain walling — Watertightness — Laboratory test under static pressure

5.1.3.2 Release of dangerous substances

5.1.3.2.1. – Presence of dangerous substances in the product

The applicant shall submit a written declaration stating whether or not the product/kit contains dangerous substances according to European and national regulations, when and where relevant in the Member States of destination, and shall list these substances.

5.1.3.2.2 – Compliance with the applicable regulations

If the product/kit contains dangerous substances as declared above, the ETA will provide the method(s) which has been used for demonstrating compliance with the applicable regulations in the Member States of destination, according to the dated EU data-base (method(s) of content or release, as appropriate).

5.1.3.2.3 – Application of the precautionary principle

An EOTA member has the possibility to provide to the other members, through the Secretary General, warning about substances which, according to Health authorities of its country, are considered to be dangerous under sound scientific evidence, but are not yet regulated. Complete references about this evidence will be provided.

This information once agreed upon, will be kept in an EOTA data base, and will be transferred to the Commission services.

The information contained in this EOTA data base will also be communicated to any ETA applicant.

On the basis of this information, a protocol of assessment of the product, regarding this substance, could be established on request of a manufacturer with the participation of the Approval Body which raised the issue.

5.1.3.3 Dampness

An assessment shall be made to ensure that dampness due to water penetration (see 5.1.3.1.3 above) or due to condensation (evaluation linked to 5.1.6.1) does not appear at any position not designed to be subjected to the prolonged effects of liquid water.

5.1.4 ER4 Safety in use

General

To study the combination of the structural sealant with the bonding surfaces, a number of mechanical properties and the effects of potentially degrading agents need to be known. The following tests are used to determine these properties.

Reminder : Unless otherwise specified in further parts of this Guideline, the tests given in clause 5.1.4 are only intended for silicone sealant and structural seal adhesion surfaces of glass (uncoated or with an inorganic coating), and anodised aluminium or stainless steel.

- Test pieces for mechanical performance

The test pieces are to be assembled by the manufacturer or in accordance with their instructions with the same material specifications used in the system, ie the structural sealant, the glass and the metal substrate as well as the surface preparation products (cleaning product, primer, etc) and treatment of surface (anodising, glass coating, etc).

The relevant reference paragraph of this document, the groups of test pieces for tensile testing, those for shear testing and the type of test pieces that need to be used, are given in Table 4.

T A B L E 4 - Type and number of test pieces

Paragraph reference	Tensile test	Shear test	Test pieces illustrated
	Initial mechanical stress		
5.1.4.1	group 1, 20 test pieces	group 2, 20 test pieces	Figure 6
	Artificial ageing or conditioning		
5.1.4.2.1 5.1.4.2.2 5.1.4.2.3 5.1.4.2.4	group 1, 10 test pieces group 1, 10 test pieces group 1, 10 test pieces group 1, 10 test pieces	- - - -	Figure 6 Figure 6 Figure 6 Figure 6
5.1.4.2.5 a 5.1.4.2.5 b	5 + 2 test pieces or 10 + 2 test pieces 5 test pieces		Figure 10 Figure 11

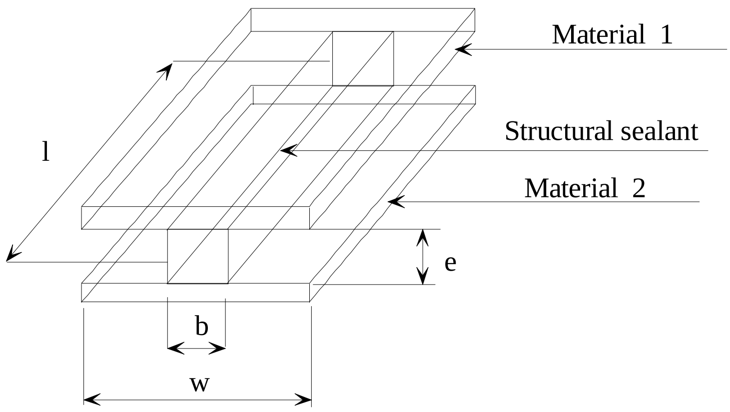


Figure 6 - Dimensions of test pieces

The substrate shall be sufficiently stiff to avoid bending.
The sample described in EN 28339 figure 2 can be used as well as the one described in ETAG 002 fig.6 for the tests mentioned in ETAG 002 table 4

T A B L E 5 - Dimensions of test pieces

Symbol	Dimensions and tolerances
b :	12 ± 1 mm
e :	12 ± 1 mm
l :	50 ± 2 mm
w :	40 ± 10 mm

Special care shall be taken to produce symmetrical test pieces.

If the test is carried out on the actual profile of the system, tension must be applied without bending the profile.

The clamps of the apparatus for tensile testing shall move in pure axial translation.

All the test samples are conditioned initially for 28 days after manufacture at a temperature of 23°C ± 2°C and at 50 ± 5 % relative humidity. Unless otherwise stated these shall also be the ambient conditions during testing.

The breaking stress of each sample shall be calculated using each breaking force and the measured dimensions of that sample. These values are then used to determine the mean value of X_{mean} and $R_{u,5}$.

5.1.4.1 Initial mechanical strength

After initial conditioning, the test pieces shall be subjected to tensile tests as shown in Figure 7 and shear tests as shown in Figure 8.

5.1.4.1.1 Tension, rupture

The aim of this test is to evaluate the resistance of structural sealant to the tensile forces acting on the joints.

After initial conditioning the test specimens shall be further conditioned for 24 ± 4 hours as follows :
- 5 test specimens conditioned at - 20°C[(1)]
- 10 test specimens conditioned at + 23°C
- 5 test specimens conditioned at + 80°C.

and then subjected to tension until failure in accordance with Figure 7.

$$\sigma = \frac{F}{b \times l}$$

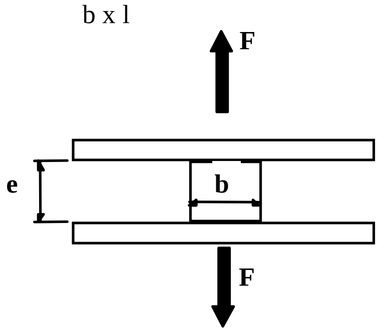


Figure 7 - Sample for tensile test - tension speed : 5 mm/min

From the stress-at-elongation graph recorded, the following shall be noted :
- the type of failure - whether cohesive or adhesive;
- stress at elongations of 5, 10, 15, 20 and 25 %;
- the stress and elongation at rupture, only for test specimens conditioned at + 23°C.

5.1.4.1.2 Shear, rupture

The aim of this test is to evaluate the inherent resistance of structural sealants to the shear forces acting on the joints.

After initial conditioning the test specimens shall be further conditioned for 24 ± 4 hours as follows :

- 5 test specimens conditioned at - 20°C(1)
- 10 test specimens conditioned at + 23°C
- 5 test specimens conditioned at + 80°C.

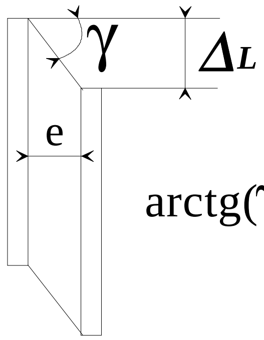
(1) This temperature can be -40°C for European nordic countries if required by the Applicant (see clause 2.2)

and then are subjected to a shear test to rupture in accordance with Figure 8.

The test is carried out at a speed of 5 mm/min.

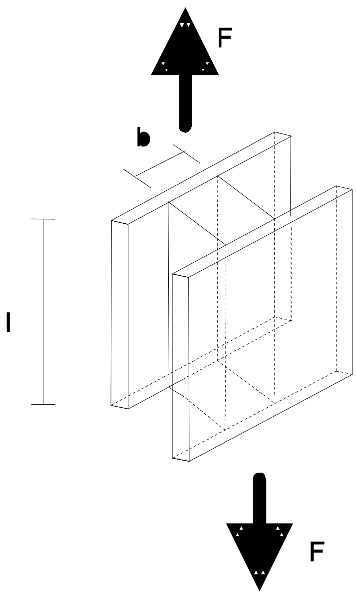
From the stress-at-elongation graph recorded, the following shall be noted :

- the type of rupture - whether cohesive or adhesive
- stress at relative displacement to thickness of the substrate (d) of 5, 10, 15, 20 and 25% and at rupture for test specimens conditioned at +23°C.



$$\operatorname{arctg}(\gamma) = \frac{\Delta L}{e} = d$$

Figure 8.a - Measurement of shear displacement



$$\tau = \frac{F}{b \times l}$$

Figure 8.b - Sample for shear test
Shear speed 5 mm/min

5.1.4.2 Residual mechanical strength after artificial ageing

5.1.4.2.1 Immersion in water at high temperature with or without solar radiation (see also clause 5.1.4.6.6)

The aim of this test is to examine the effect of artificial ageing on the residual mechanical strength of the structural sealant. A direct correlation between natural solar ageing and accelerated UV ageing is not completely established at present.

For glass substrates the test procedure combines immersion in water at high temperature with solar radiation.
(see Figure 6 with material 1 a glass product and material 2 a metallic product)

The test pieces are conditioned in accordance with ISO DIS 11431 - 1991:

- conditioning method A
- procedure 1 with modified tolerance on water temperature : 45 ± 1 °C and with an energy of 500 to 800 Watts. The test pieces are immersed in demineralised (resistivity 1 to 10 MΩ) hot water with the upper substrate (glass) flush with the water level. (Figure 2 of ISO DIS 11431 - 1991).

For metallic substrates the test procedure involves full immersion in water at high temperature without solar radiation.
(see Figure 6 with material 1 a metallic product and material 2 a metallic product)

The test pieces are fully immersed (at least 20 mm under the water level) in demineralised (resistivity 1 to 10 MΩ) hot water, temperature 45° ± 1°C.

For both substrate combinations the procedure is as follows:

After 21 days (504 ± 4 hours) of conditioning, five test pieces are to be removed from the chamber and conditioned for 24 ± 4 hours at a temperature of 23 ± 3°C and 50 ± 5 % relative humidity.

The test pieces are then to be subjected to a tensile test in accordance with clause 5.1.4.1.1

After a further 21 days (504 ± 4 hours) the five remaining test samples are to be removed from the chamber and subjected to the same tensile test after the same conditioning.

The test results shall include :

- the date and time when the test started
- the temperature, relative humidity and period of initial conditioning

during the immersion in water :

- a record of the water temperature
- a record of the temperature at the interface of the control samples
- water conductance values noting the date and time of measurement.

after removal from the water :

- the dates and times of removing samples
- the record of temperature, relative humidity and conditioning period after immersion in water;
- the date, time, temperature and relative humidity during the tensile test
- the stress/strain curve.

5.1.4.2.2 Humidity and NaCl atmosphere

The conditioning shall be carried out in accordance with ISO 9227 - atmosphere NSS maintained for 480 hours for uncoated glass, glass coated on face 4 (see Figure 9) and other substrates, and for 240 hours for glass coated on faces 2 and 3. The test pieces are placed on PVC-trays. Every 24 hours, the test pieces are to be turned to expose each longitudinal cut edge in turn.

After conditioning, the test pieces shall be conditioned for a further 24 ± 4 hours at a temperature of 23 ± 2°C and 50 ± 5 % relative humidity. They shall then to be subjected to tensile tests in accordance with clause 5.1.4.1.1.

5.1.4.2.3 Humidity and SO_2 atmosphere

The 10 test pieces shall be conditioned in accordance with ISO 3231

- atmosphere 0,20 litres of SO_2
- 20 cycles for uncoated glass, glass coated on face 4 (see Figure 9) and other supports
- 10 cycles for glass coated on faces 2 and 3.

After conditioning, the test pieces shall be removed from the chamber and further conditioned for 24 ± 4 hours at a temperature of 23 ± 2°C and 50 ± 5 % relative humidity.

Thereafter, they shall be subjected to tensile tests in accordance with clause 5.1.4.1.1

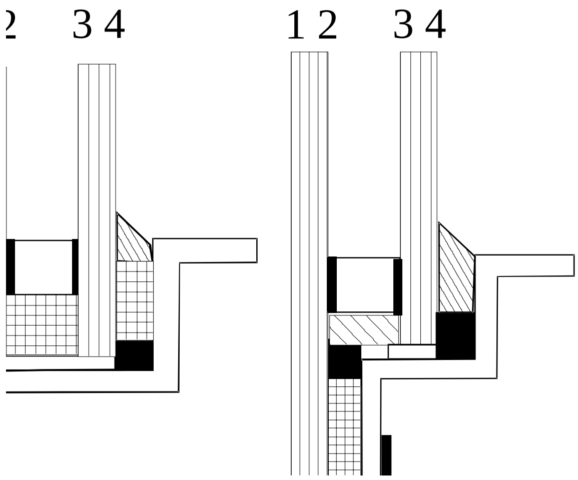


Figure 9 - Numbering of insulating unit faces

5.1.4.2.4 Facade cleaning products

The aim of this test is to assess the effect of cleaning products on the structural bond.

The test pieces shall be immersed for 21 days in the cleaning product(s) (as used in practice) and stored at a temperature of 45 ± 2°C. The products shall be those recommended by the facade supplier.

After conditioning, the test pieces shall be removed from the cleaning products and further conditioned for 24 ± 4 hours at a temperature of 23 ± 2°C and 50 ± 5 % relative humidity. They shall then to be subjected to tensile tests in accordance with clause 5.1.4.1.1.

5.1.4.2.5 Effects of materials in contact

The stability of an SSGS can be affected by incompatibility between the structural sealant and other materials which may be indicated by discoloration of one of the materials. The following test is designed to investigate this interaction.

It is vital for the test pieces to be prepared with all the material specifications used in the system, such as structural sealant, weather sealant, spacer materials, aluminium and glazing, as well as manufacturing materials, such as preparatory and cleaning products.

Two test methods are proposed to verify compatibility. It is for the approval body to decide the most appropriate. 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

Seven test pieces shall be produced as shown in Figure 10 and conditioned at a temperature of 60 ± 2°C and 95 ± 5% relative humidity, five for 28 days and the remaining two for 56 days.

Special care shall be taken to produce symmetrical test pieces. The sequence of operations when producing the samples shall reproduce that used in practice.

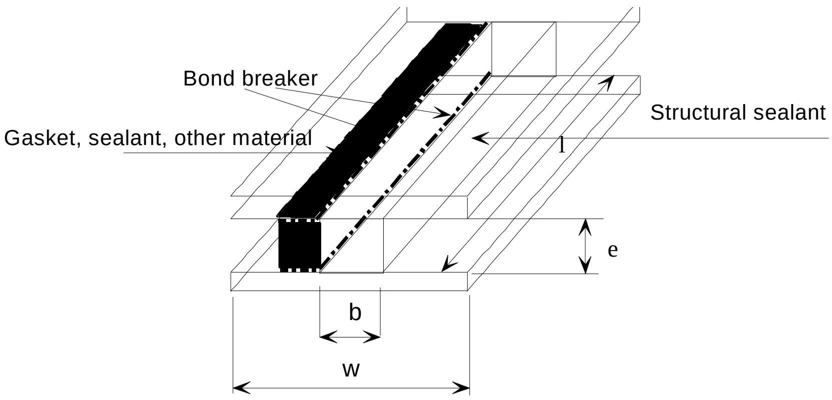


Figure 10 - Typical sample for compatibility test

The samples shall be tested as follows:

- Mechanical strength: Five test pieces shall be subjected to the tensile test in accordance with clause 5.1.4.1.1 after 28 days 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 discolouration every 14 days throughout the 56 day conditioning period.

b) Method with UV

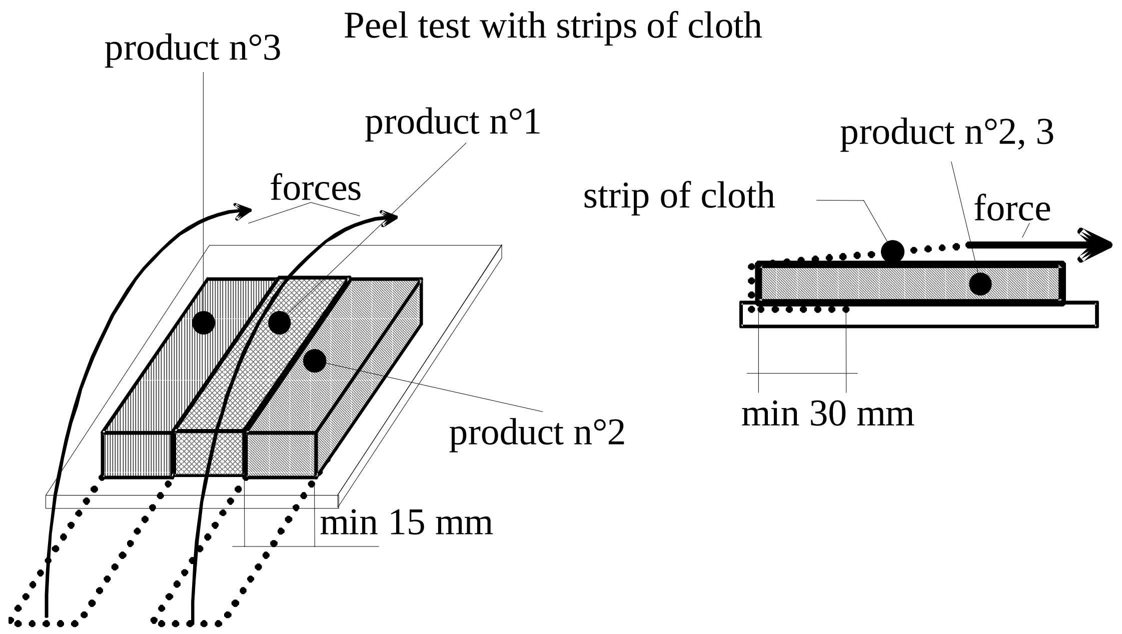
Test procedure

Five tests pieces shall be made as shown in Figure 11.

Products 2 and 3 are sealants with which compatibility with product n°1 is being checked. It may be necessary in some cases to make this test with a pale colour sealant specially supplied for the purpose to ensure that any migration is visible. The pale colour sealant must have the same curing system as the product normally used.

After 1 to 3 days of cure of the various products, the test pieces are submitted to irradiation using a UV lamp
- Type of lamp : Xenon or equivalent
- Power: 50 ± 5 W/m² measured at the level of the sample, and between 300 and 400 nm
- Temperature : 60 ± 2°C
- Duration : 504 ± 4 hours.

If adhesion has occurred between products n° 1 and 2 or 1 and 3, a clean incision shall be made to separate them.



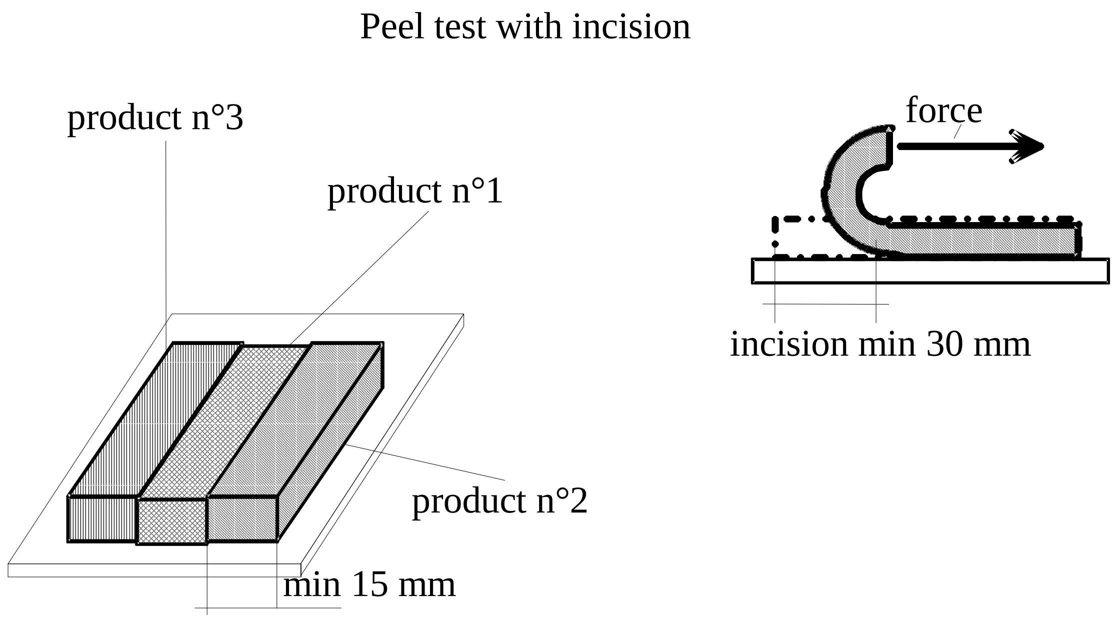


Figure 11 - Peel test - alternatives

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 the products n° 2 and 3.
The sealant beads are manually peeled back at 180° to the substrate.
Any signs of staining in the pale-colour sealant are noted.

5.1.4.3 Mechanical devices

5.1.4.3.1 Test on the mechanical self-weight support

Normally the structural adequacy of such supports is assessed using conventional calculations based upon the strength of materials and testing will not be required. Where the design incorporates novel features the following test can be used.
Remark : the supporting devices shall not cause any damage to the glass

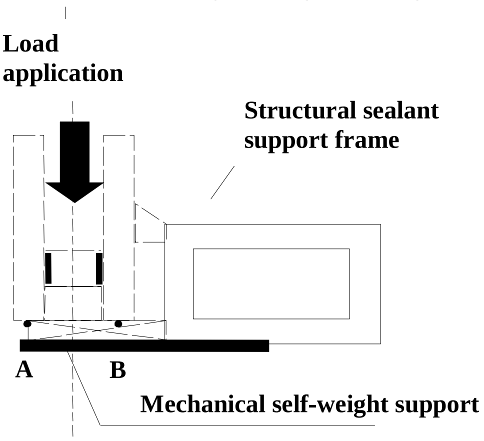


Figure 12 - Test on mechanical self-weight support

The test piece comprises a mechanical self-weight support connected to the structural sealant support frame. The test piece shall reproduce the shape and the usage in the SSGS.

A vertical force simulating the self-weight of the glass is applied at the theoretical centre of gravity of the insulating unit by a means which guarantees that the line of action is vertical.

When loaded, the displacement of the mechanical self-weight support is measured at the points A and B (see Figure 12).

5.1.4.3.2 Test on the anchorage of the sealant support frame to the facade structure

Normally, these fixings may be assessed by conventional calculation. Where the design precludes this, one of the following tests may be used.

Generalities for both methods :

F_{des} = design resistance
τ = safety factor
$F_{u,5}$ = the characteristic force giving 75% confidence that 95% of the test results will be higher than this value
F_{mean} = the average breaking force
$\tau_{\alpha ß}$ = the eccentricity of 5 % with a 75 % confidence
s = the standard deviation of the series under consideration
$P_{br,n}$ = breaking pressure, initial state
$P_{br,c}$ = breaking pressure, after ageing test

a) Method I

The test apparatus shall accurately reproduce the manner in which the fixing is loaded.

- For metallic anchorages, or when $\tau = 3$ is required by the applicant, a static test only shall be undertaken.

  Static test :

  Five anchorages shall be submitted to tension until break, using a tension speed of 1 mm / minute
  The characteristic static breaking force $F_{u,5}$ value shall be calculated by the formula :

  $F_{u,5} = F_{mean} - \tau_{a\beta} . s$ where $\tau_{\alpha\beta} = 2,46$ (see table 7 section 6)
  $F_{des} = F_{u,5} / \tau$

- For other anchorages, or when $2 \leq \tau \leq 3$ is required by the applicant, a static and dynamic test shall be undertaken.

  Static test :

  See above static test for metallic anchorage with $\tau = 3$

  Dynamic test :

  Five anchorages shall be subjected to repetitive tensile loads with the cycle described in Figure 16, as follows :

  100 times from $0.1 \times F_{des}$ to F_{des}
  250 times from $0.1 \times F_{des}$ to $0.8 \times F_{des}$
  5000 times from $0.1 \times F_{des}$ to $0.6 \times F_{des.}$

  (for a description of the cycle, see Figure 16).

b) Method II

When it is impossible to test separately the anchorage of the sealant support frame to the facade structure, the anchorage can be tested on a glazed test assembly as shown in Figure 13.

When the anchorage is designed to take also the dead load as well as the wind, the test sample will be submitted to maximum dead load allowed at each anchorage with a safety factor γ of 1.1.

Static pressure to rupture:

One assembly equipped with four anchorages on a pressure test wall shall be submitted to pressure to the point of rupture. The pressure is always to simulate an external suction. $P_{br,n}$ is the rupture pressure. The sample is preferably a square

Dynamic test:

A second sample shall be subjected to fatigue cycles, as follows :

20 times from $0,1 \times P_{br,n}$ to $0,75\ P_{br,n}$; gust of max. 8 seconds, gust cycle, see Figure 16
200 times from $0,1 \times P_{br,n}$ to $0,50 \times P_{br,n}$; gust of max. 8 seconds, gust cycle, see Figure 16
200,000 times from $0,1 \times P_{br,n}$ to $0,25 \times P_{br,n}$; gust of 1 second, no particular cycle required
1 time from $0,1 \times P_{br,n}$ to $0,9 \times P_{br,n}$; $0,9 \times P_{br,n}$ is the cycle peak value, no particular cycle required

After the dynamic test, the static test to rupture is undertaken on the second sample to determine $P_{br,c}$

$F_{des} = P_{br,n} \times a^2 / 4 \times \tau$ where $\tau \geq 2$ and 'a' = side of the rig see fig. 13

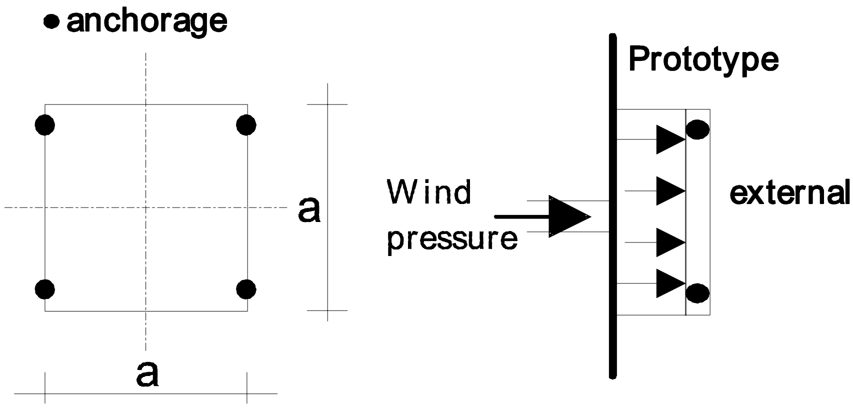


Figure 13 - Test assembly for Method II

5.1.4.3.3 Tests on retaining devices

The performance of the devices shall be assessed either from the results of tests or from calculations which shall allow for the method of attachment to the frame. The variety of designs is such that the approval body will decide upon a relevant approach. The devices shall not themselves cause damage to the glazing.

5.1.4.4 Tests on opening lights

The following tests are to be carried out in accordance with the UEAtc [2] 'Directive for the Assessment of Windows' to assess the effect of operation, on the structural bond:

- Mechanical tests applicable to opening windows : paragraph 1.3. of chapter III
- Durability tests : 10,000 cycles of opening and closing the windows in accordance with paragraph 1.3. of chapter III
- To assess the overall fitness for use of the hardware fitted to opening lights, the approval body may make use of information derived from documented sources, such as listed experience, previous approval procedures, references to standards, etc.

5.1.4.5 Impact tests

The impact resistance of a light facade is governed by its design features, therefore impact resistance can vary from building to building using the same SSGS.
If required, the impact resistance of the facade sample shall be tested following the procedure described in the UEAtc [3] Directive "Light Cladding", Section III - General quality rules - chapters 1,2 and 1,3.

5.1.4.6 Structural sealant - Physical properties

5.1.4.6.1 Gas inclusions

With certain structural sealants gas bubbles can form at the glass/aluminium-structural sealant interfaces; these can affect the performance of the structural sealant.

One test piece (see Figure 14) with a float glass upper face is prepared in accordance with the structural sealant manufacturer's specifications. The structural sealant shall fill, completely and without any air pockets, the space created between the glass and the aluminium.

The test specimen shall be stored at a temperature of 23 ± 2°C and at a relative humidity of 50 ± 5 % for 21 days. After each 7 days, the test specimen shall be checked visually. Generation of gas bubbles and their rate of growth shall be recorded.

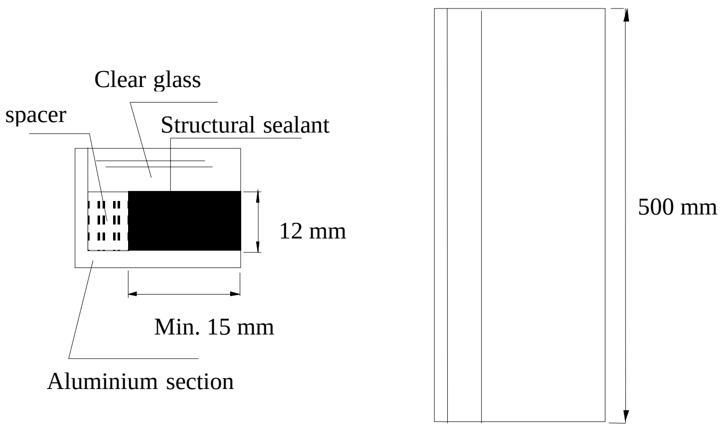


Figure 14 - Sample for gas inclusion test

5.1.4.6.2 Elastic recovery

This test is to be used for evaluating the elastic relaxation behaviour and consequently the relaxation behaviour after long-term loading.

The test shall be carried out on three samples in accordance with EN 27389 standard (ISO 7389), method A with 25% extension

The following shall be noted :

- the initial stress and elongation
- the final stress and elongation
- the elongation after unloading the test pieces.

5.1.4.6.3 Shrinkage

The aim of this test is to evaluate the degree of shrinkage of the structural sealants to limit the initial stresses in the SSG joints. The test shall be carried out in accordance with ISO 10 563 on three samples.

5.1.4.6.4 Resistance to tearing

The aim of this test is to establish the mode of propagation of a cut in the structural sealant.

Five test samples shall be produced and cut at the ends of the structural sealant as shown in Figure 15. The incisions shall be clean, without removal of material. The samples shall then be subjected to a tensile test in accordance with 5.1.4.1.1.
The average breaking stress for the reduced measured surface (e.g. 40 x 12 = 480 mm^2) is calculated.

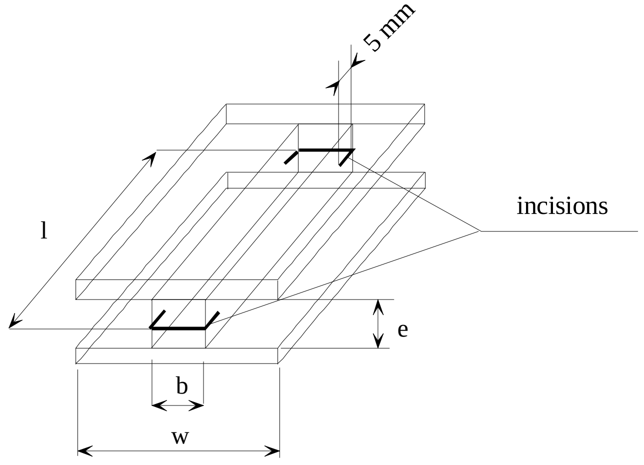


Figure 15 - sample for incision test

5.1.4.6.5 Mechanical fatigue

The aim of this test is to examine the effect of fatigue stresses on the residual mechanical strength of the sealant bond.

Ten test pieces in accordance with Figure 6 are to be conditioned for 28 days at a temperature of 23 ± 2°C and 50 ± 5% relative humidity.

The test pieces are then to be subjected to repetitive tensile loads with a cycle time of 6 seconds (Figure 16) :
100 times from 0.1 σ_{des} to the design stress σ_{des}
250 times from 0.1 σ_{des} to 0.8 x the design stress σ_{des}
5000 times from 0.1 σ_{des} to 0.6 x the design stress σ_{des}

where $\sigma_{des} = R_{u,5} \backslash 6$ (see clause 6.1.4.1.1, with $R_{u,5}$ at 23 °C)

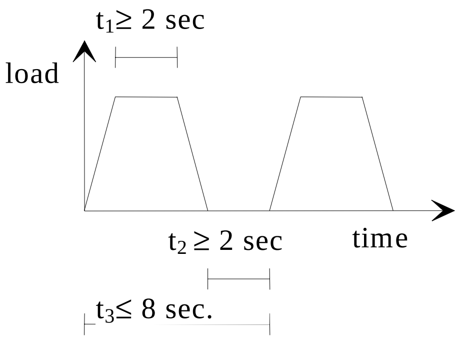


Figure 16 - Stress cycle for fatigue test
with "t_1" : duration of the peak load, "t_2" : rest time," t_3" total time of the cycle

After cycling, the structural bonds shall be visually inspected.

The ten test pieces shall then be conditioned for a further 24 ± 4 hours at a temperature of 23 ± 2°C and 50 ± 5 % relative humidity, and then subjected to the tensile test in accordance with 5.1.4.1.

5.1.4.6.6 UV resistance of the sealant

If necessary, for example to determine the origin of problems occurring during the test detailed in 5.1.4.2.1 with UV, the resistance to UV of the structural sealant itself can be estimated according to the following method. It should be noted that the number of UV hours applied in this test serves to make a distinction between products that behave well under such radiation and those that do not. A direct correlation between natural solar ageing and accelarated UV ageing is not completely established at present.

Ten test pieces are manufactured as the type 5 test pieces of ISO 527-3 with all the test pieces having a thickness of 2.2 ± 0.2 mm (these samples may also be used for the tests prescribed in 5.1.4.6.7).

Five test pieces are then to be subjected to the tensile test as in ISO 527, speed 5mm/min.

Five test pieces are subjected to UV irradiation as follows :

- Type of lamp: Xenon, or equivalent
- Power: 50 ± 5 W/m² measured at the level of the sample, between 300 and 400 nm.
- Duration: 504 ± 4 hours.

After irradiation, these five test pieces are to be subjected to the tensile test as per ISO 527, speed 5mm/min.

5.1.4.6.7 Elastic modulus of the sealant

The aim of this test is to determine the calculation modulus E_0, which is to be taken into the method of calculation given in annex 2.

Five test pieces shall be manufactured as the type 5 test pieces of ISO 527-3 with all the test pieces having a thickness of 2,2 ± 0,2 mm. The test procedure is described in the ISO 527-3 with the speed of 5 mm/min. The manufacturer shall give the modulus type to be introduced in the calculation, either tangent or secant to the origin. In the latter case, the boundaries of the curve (deformation, stress $(\varepsilon_1, \sigma_1), (\varepsilon_2, \sigma_2)$) between which the calculation modulus is to be performed shall also be given.
The maximum relative elongation allowed in the calculation shall be that corresponding to the upper boundary used to determine the calculation modulus.

The test report shall contain the graphs (deformation, stress) for each sample.

5.1.4.6.8 Creep under long-term shear and cyclic tensile loading

The aim of this test is to evaluate the creep under long term shear and tensile loading and to determine the creep factor γ_c.

Creep factor - definition

Factor γ_c by which the Γ_{des} shall be divided, to obtain a stress Γ_∞ for which no creep is measurable following the criteria of the test described below. γ_c shall always be ≥ 10 :

where Γ_{des} : see appendix 2, part A
Γ_∞ : given by the manufacturer

$$\gamma_c = \frac{\Gamma_{des}}{\Gamma_\infty}$$

a) Test specimen

Three test pieces (as illustrated in Figure 17) shall be assembled by the manufacturer or in accordance with their instructions. The support thickness shall be ≥ 6 mm. The sample dimension “e” (see fig. 17) is to be given by the sealant manufacturer.

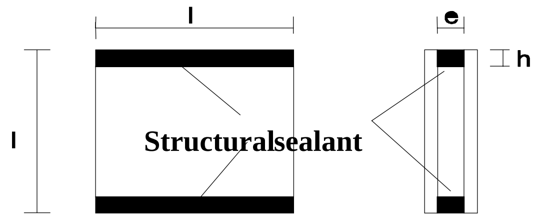


Figure 17 - Sample geometry

b) Test procedure

Climatic conditions

All the test samples shall be conditioned for 28 days after manufacture at a temperature of 23°C ± 2°C .
The loading described below shall be applied in a climatic chamber where the atmosphere has 95 ± 5% RH and a temperature of 55 ± 2°C.

Loading (see Figure 18)

- *Tensile loading*

The three test pieces are subjected to tensile loading M_1 with loadings steps of :

$$M_1 = 2 \,.\, h \,.\, l \,.\, P_x$$
with l = 200 mm,
h = 9 mm
$$M_1 = 3600 \,.\, P_x$$

with $P_{(x=1 \text{ to } 3)}$: $P_1 = 1 \times \sigma_{des.}$ for 7 days
$P_2 = 0.6 \times \sigma_{des.}$ for 14 days
$P_3 = 0.3 \times \sigma_{des.}$ for 70 days

and $\sigma_{des} = R_{u,5}/6$ with $R_{u,5}$ determined at 23 °C see 6.1.4.1.2

• *Permanent shear loading*

Simultaneously, with the tensile loading above, the samples shall be loaded with a weight M_2 calculated on the basis of the permanent shear stress given by the manufacturer's Γ_∞ , taking into account a minimum creep factor of 10.

$$M_2 = 2 \,.\, h \,.\, l \,.\, \Gamma_\infty$$
with h = 9 mm,
l = 200 mm
$$M_2 = 3600 \,.\, \Gamma_\infty$$

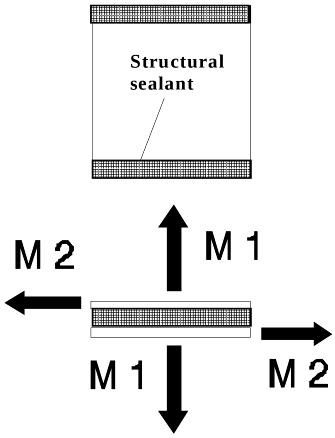


Figure 18 - Loading principle

Test duration

The overall duration of the test shall be 91 days and the interval time for creep measurements 1 day, 3 days, 7 days, then each 7 days after loadings steps. Measurements shall be made on the loaded sample.

The test results shall include:

- The date and time when the test started
- The temperature and relative humidity during the period of initial conditioning and during the subsequent conditioning in the climatic chamber
- The creep evolution at 1 day, 3 days, 7 days, then each 7 days after loadings steps
- The deformation after 91 days before unloading
- The residual deformation 24 hours after unloading.

5.1.4.7 Method of calculation of structural seal dimensions

The normal limits for the SSGS are :

- minimum thickness of the seal : 6 mm
- 6 mm $\leq$ bite of the seal $\leq$ 20 mm
- maximum sealant support frame deflection : 1/300 between anchorages, ignoring the glass stiffness
- maximum deflection in the middle of the pane 1/100 (smallest side).

For the detailed methods of calculation, see annex 2.

5.1.4.8 Sill heights

The range of possible sill heights is noted.

5.1.4.9 Wind resistance

Test procedure : This test shall be carried out in accordance with the UEAtc Directive for the Assessment of Windows (clause 1.2.1) and with a test sample as described in 5.1.3.1.1.

Increased load test (positive and negative wind loads)

The deflection shall be measured at the centre of the rig structure (mullion or transom) as a function of the pressure and reported in tabular or graphic form. With the differential pressure reduced to zero, the permanent deflection shall be noted after 15 minutes' recovery. A visual inspection shall be made for damage to the glass and/or induced stresses caused by the retaining devices. The pressure reached without defect or damage shall be noted.

5.1.4.10 Behaviour in fire

Determination if behaviour in fire will be necessary, using the relevant fire resistance test (see CEN classification documents) where glazing is used which has a degree of fire resistance even where no particular fire resistance is claimed.
Testing may be avoided by use of existing knowledge of behaviour of some glass types in fire.

5.1.5 ER5 Protection against noise - Acoustic insulation

The acoustic insulation of a facade will be governed by the design (size of the glazed elements, presence of opening lights, type and width of glazing, etc) and the installation (airtightness, etc).

At the moment no standardized calculation method or model is in existence with which to determine the acoustic insulation of a facade. However, a number of methods of calculation are available based on the fundamental mathematical laws concerned with acoustic insulation, i.e. the Laws of Mass and Frequencies, etc.

These methods are generally complicated and the effective result on site is greatly influenced by the care taken in assembly of the facade.

Where specific acoustic properties are claimed, these claims shall be checked by applying EN-ISO 140-3.

5.1.6 ER6 Energy economy and heat retention

5.1.6.1 Thermal insulation

The thermal insulation and/or the susceptibility to condensation of a facade will be governed by the design (size of the glazed elements, the presence of opening lights, type and width of glazing, etc) and the installation (airtightness, etc).

Considering the typical detail shown in Figure 4, it is necessary to allow for a number of materials and their interactions resulting in a number of different U (thermal transmittance) values.

Thermal insulation and/or the susceptibility to condensation (see 5.1.3.3) may be determined by test or calculation, as follows:

a) Aggregate test method

This method involves determining the laboratory steady-state thermal transmission properties of building components for industrial use as per prEN 12412. Measuring method for the determination of the aggregate thermal transmittance [U-value (W/m² K)] for window systems or doors — the calibrated and guarded Hot Box methods.

The results are expressed in accordance with chapters 7.3 and 8 of the document prEN 12412. This test is optional.

b) Calculation method

Thermal modelling of a SSGS can be undertaken using thermal conductivity (λ) values determined by the relevant European methods (such as prEN ISO 10077-2/1997) in conjunction with various computer software. To use the results of these programs, it is necessary to ensure that the program is at least two dimensional and covers all the required parameters.

5.1.6.2 Air permeability

The determination of air permeability is covered under 5.1.3 Hygiene, health and the environment

5.1.7 Durability aspects

There are no specific aspects of durability to be tested or assessed which have not been covered under other headings.

5.2 Verification methods related to the identification of the products

5.2.1 Structural sealant

The following determinations of characteristics are valid for all the types of silicone structural sealant used in SSG systems.

The identification tests constitute the structural sealant's identity card, comprising at least the graphs and values obtained from the following tests when carried out under well-defined conditions.

5.2.1.1 Specific mass

Determination of the specific mass on three specimens in accordance with the ISO 1183 standard, method A.

5.2.1.2 Hardness

Measurement of the shore A hardness in accordance with the ISO 868.

The measurement shall be carried out on three test pieces after full polymerization, i.e. :

- after 28 days for single-component silicones
- after 7 days for two-component silicones.

5.2.1.3 Thermogravimetric analysis

This identification test seeks to determine the products of the thermal decomposition. Losses are quantified as a function of an even temperature increase.

The test shall be carried out in accordance with ISO 7111 on one specimen.
The results are drawn from the graph of the readings expressed in terms of :

- TG, the percentage of cumulative losses up to 900° C
- DTG, the zones of maximum loss through volatilization
- DTA, exo- or endothermal conversion zones.

5.2.1.4 Colour

The colour shall be observed visually, by reference to the colour scale in ISO 4660.

5.2.2 Anodised aluminium structural adhesion surface

5.2.2.1 Alloys of aluminium

The specification for the alloy of aluminium shall be examined for suitability in the SSGS.

5.2.2.2 Characteristics of the anodising

The aluminium structural adhesion surface on which the tests in clause 5.1.4 are to be performed, are identified as follows (see table 8.6 regarding possible use of the Qualanod mark):

5.2.2.2.1 Measurement of the thickness

The following methods may be used:

- Eddy current test method to ISO 2360
- Split-beam optical method to ISO 2128
- Microsection method to ISO 1463
- Gravimetric method to ISO 2106.

5.2.2.2.2 Sealing tests

The following methods may be used :

- Stain test to ISO 2143
- Immersion test to ISO 3210
- Measurement of admittance test at 1000 Hz to ISO 2931.

5.2.2.2.3 Measurement of the admittance at 20000 Hz

The measurement is made at 20000 Hz but otherwise following the same test procedure as described in ISO 2931.

5.2.2.3 Description of the anodising process

The applicant shall give the approval body the following information :

5.2.2.3.1 Scouring

Composition of the bath
Time of immersion of aluminium in the bath

5.2.2.3.2 Anodic oxidation

Composition of the bath
Time of immersion of aluminium in the bath
Temperature of the bath
The bath shall be stirred to ensure an even temperature distribution throughout the bath.

5.2.2.3.3 Sealing [(1)] of the anodised layer

Composition of the bath or reference name
Time of immersion of aluminium in the bath
Temperature of the bath

Where cold sealing is proposed additional proof must be provided by the manufacturer.

[(1)] A misunderstanding can arise from the word "sealing" which is a post-treatment of the anodising. The equivalent in French is "colmatage" and in German "Verdichtung"

5.2.3 Glass adhesion surface

5.2.3.1 Identification of glass

The applicable glass and glass products are identifiable by reference to the various European standards.
The type of glass used to form the samples for the adhesion-cohesion tests in chapters 5.1.4.1 and 5.1.4.2 is usually a normal float glass conforming to prEN 572. The results of these tests can be extrapolated for thermally-toughened or heat-strengthened glass. For safety reasons, special types of glass can be required for particular projects. The fragmentation shall be tested following the EN or prEN concerning the type of glass.

5.2.3.2 Glass products

Where double- or multiple-glazing units are to be used, these must be suitable for use in SSG systems. The hermetic seal must meet the requirements of the relevant standards; where required to act as a structural bond it must also meet the requirements of this Guideline to prove its adequacy.

5.2.3.3 Coated glass

5.2.3.3.1 Suitable coatings

Suitable coatings are the inorganic coatings classified as A, S and B to the European draft standard prEN 1096 Coated glass for buildings. Other coatings meeting prEN 1096 shall be removed along the structural sealant adhesion surface unless they have been shown to be suitable after tests in accordance with another part of this Guideline.

The manufacturer shall establish a list of the coatings applicable in SSG systems, giving the composition of these coatings in layers.

The layers may be listed in full, giving their composition by name and the manufacturer's unique reference.

Further coatings may be added to an amended ETA when they have been shown to be suitable in SSG systems.

5.2.3.3.2 Evaluation of the suitability of the bonding of coatings and their layers

For each coating on a structural sealant adhesion surface, it shall be demonstrated that the bonding between glass and coating, between sealant and coating, and between the different layers of the coating, is sufficiently strong. Such a demonstration consists normally of adhesion tests and assessment according to the following chapters of this Guideline :

- Chapter 4 Requirements
- Chapter 5 Methods of verification
  - 5.1.4.1 Initial Mechanical Strength
  - 5.1.4.1.1 Tension, rupture
  - 5.1.4.1.2 Shear, rupture
  - 5.1.4.2 Residual mechanical strength after artificial ageing
  - 5.1.4.2.1 Immersion in water at high temperature with or without solar radiation
  - 5.1.4.2.2 Humidity and NaCl atmosphere
  - 5.1.4.2.3 Humidity and SO_2 atmosphere
  - 5.1.4.2.4 Facade cleaning products
- Chapter 6 Assessing and judging the fitness for use of products for an intended use

5.2.3.3.3 Evaluation from existing test reports

When a coating is submitted for an evaluation for suitability, the manufacturer may present existing test reports containing the outcome of testing on coatings, consisting of:

- the bonding between the particular sealant and the particular top layer of the coating
- and/or the bonding between the glass and the particular base layer of the coating
- and/or the interlayer bonding between any two layers of the coating.

5.2.3.3.4 Evaluation by testing

Where absence of data does not allow an evaluation for suitability of a particular coating, layer or coating/sealant combination, tests shall be carried out using the following process:

Requirements:
Coating I to be submitted to evaluation for suitability: [glass] - [layer 1 - layer 2] - [sealant A]
Coating II to be submitted to evaluation for suitability: [glass] - [layer 2 - layer 1] - [sealant A]

Available information:
Existing report 1 establishes that the combination [glass] - [layer 1 - layer 2 - layer 3] - [sealant B] is fit for use
Existing report 2 establishes that the combination [glass] - [layer 2] - [sealant A] is fit for use

Conclusions

Coating I :
Accepted because :

i) The combination glass - layer 1 is fit for use (resulting from report 1)
ii) The combination layer 1 - layer 2 is fit for use (resulting from report 1)
iii) The combination layer 2 - sealant A is fit for use (resulting from report 2).

Coating II :

Acceptable after testing a coating containing the bonding: layer 1 - sealant A because:
i) The combination glass - layer 2 is fit for use (resulting from report 2)
ii) The combination layer 2 - layer 1 is fit for use (resulting from report 1)
iii) But the combination layer 1 - sealant A was not previously tested.

5.2.4 Stainless steel adhesion surface

Structural sealant adhesion surfaces in the form of rolled or pressed stainless steel are considered in this document, provided that they can be shown to comply with the following chapters and that structural sealant bonds made to them form a satisfactory system when tested in accordance with this document:

- Chapter 4 Requirements
- Chapter 5 Methods of verification
  - 5.1.4.1 Initial mechanical strength
  - 5.1.4.1.1 Tension, rupture
  - 5.1.4.1.2 Shear, rupture
  - 5.1.4.2 Residual mechanical strength after artificial ageing
  - 5.1.4.2.1 Immersion in water at high temperature with or without solar radiation
  - 5.1.4.2.2 Humidity and NaCl atmosphere
  - 5.1.4.2.3 Humidity and SO_2 atmosphere
  - 5.1.4.2.4 Facade cleaning products
- Chapter 6 Assessing and judging the fitness for use of products for an intended use.

5.3 Verifications necessary in case of interchange of components or suppliers

It must be ensured that with an interchange of a component, the new component does not have a negative influence on the performance level or the life of the SSGS.

For components specified as described in 4.9 (i) it has to be proven that new components have the same characteristics as the ones they replace and that they have little or no influence on the characteristics of the SSGS. Furthermore it must be ensured that the new component is compatible with other components for the envisaged lifetime. Compatibility tests shall be performed to ensure that the exchanged components do not have a negative influence or effect on the components with which it interacts in the system. For components specified as described in 4.9 (ii) the origin has no influence on the performance.

When interchanging a component specified in terms of 4.9(i), the body issuing the ETA will determine the test regime as is deemed necessary based on its experience and using the table below. If in doubt, the issuing body can consult the other European bodies.

The following table lists the components likely to be substituted and the tests for their assessment, if necessary. Substitution of more than one component may need to be the subject of a deeper analysis as the overall basis for the acceptance of the kit may no longer be valid. The table is not exhaustive and can be adapted to peculiarities of certain systems.

The tests refer either to tests in this Guideline or to CEN standards.

T A B L E 6 - Component interchange

Component	**Test for characteristics**	**Identification tests**
Structural seal	5.1.2 5.1.4.1; 5.1.4.2; 5.1.4.4; 5.1.4.6	5.2.1
Mechanical selfweight support	5.1.4.3.1	
Anchorages	5.1.4.3.2	
Safety devices	5.1.4.3.3	
Glass	-	5.2.3.1
Coating for glass	5.2.3.3	
Aluminium anodizing	5.1.4.1 5.1.4.2	5.2.2
Weather seal	Compatibility test 5.1.4.2.5	
Setting block	Compatibility test 5.1.4.2.5 and SHORE 70	
Spacer, backer rod	Compatibility test 5.1.4.2.5	

6 Assessing and judging the fitness for use of products for an intended use

6.0 Preamble

Chapter 6 details the performance requirements to be met by Structural Sealant Glazing Systems into precise and measurable (as far as possible and proportional to the importance of the risk) or qualitative terms, related to the products and their intended use, using the verification methods (chapter 5).

Each performance requirement to be met for a given intended use, in general, is assessed for classes, use categories or numerical values. The ETA in general shall indicate either the results of these assessments or state “No performance determined” (for countries/regions/buildings where no requirements given in laws, regulations and administrative provisions are applicable). This statement does not mean that the SSGS performs badly, but merely that this specific performance property has not been tested and assessed.

For results outside the requirements given below, the approval body shall subject them to a deeper analysis based on a larger number of test pieces, repeating any questionable tests or other measurements related to the problem concerned.

6.1 General - test result statistical interpretation

$$R_{u,5} = X_{mean} - \tau_{\alpha\beta} \cdot s$$
$$\Delta X_{mean} = X_{mean,c}/X_{mean,n}$$

where

$R_{u,5}$ = the characteristic breaking stress giving 75% confidence that 95% of the test results will be higher than this value.
X_{mean} = the average breaking stress, either under tension or shear.
$X_{mean,n}$ = the average breaking stress, either under tension or shear in the initial state.
$X_{mean,c}$ = the average breaking stress, either under tension or shear after conditioning or ageing.
$\tau_{\alpha\beta}$ = the eccentricity of 5 % with 75 % confidence (see table 7)
s = the standard deviation of the series under consideration

and also

V_{mean} = Mean value
K_x = stiffness of the sample at x % elongation in the initial state
$K_{x,c}$ = stiffness of the sample at x % elongation after conditioning
R_{des} = design resistance
$F_{u,5}$ = the characteristic force giving 75% confidence that 95% of the test results will be higher than this value
F_{mean} = the average breaking force

T A B L E 7 - The variable $\tau_{\alpha\beta}$ as a function of the number of test pieces (see ISO 3207).

Number of pieces	5	6	7	8	9	10	15	30	∞
Variable $\tau_{\alpha\beta}$	2,46	2,33	2,25	2,19	2,14	2,10	1,99	1,87	1,64

Note : Type of rupture

A number of tests prescribe "Rupture ≥ 90% cohesive", i.e. the rupture of the samples shall be located at least 90% within the sealant and a maximum 10 % at the interface between the sealant and the glass or metallic substrate.

T A B L E 8.1 - **ER1 and ER 2**

Reference	Verification methods	Reference	Treatment of results and requirements - criteria
ER1 Mechanical resistance and stability — not relevant to SSGS			
ER2 Safety in case of fire			
5.1.2.1	Reaction to fire	6.1.2.1	Classes according to EC decision and CEN classification document.
5.1.2.2	Resistance to fire	6.1.2.2	Classes according to ID No 2, clause 4.3.1.3.5.2 and CEN classification document.
5.1.4.10	Behaviour in fire (see also ER4)	6.1.4.10	Classification according to CEN classification document.

T A B L E 8.2 **- ER3**

Reference	Verification methods	Reference	Treatment of results and requirements - Criteria
ER3			
ER3 Health, Hygiene and the Environment			
5.1.3.1	Air permeability Watertightness	6.1.3.1	prEN 12152 - No performance determined option possible prEN 12154 - No performance determined option possible
5.1.3.2	Air quality / Dangerous substances	6.1.3.2	No prolonged moisture condensation may occur out of the drained zone or on the interior face of the facade. Handling see clause 6.2 – no performance determined option possible.

T A B L E 8.3 - **ER4**

Reference	Verification Methods	Reference	Treatment of results and requirements – Criteria
ER4 Safety in Use			
5.1.4.1 Initial Mechanical strength			
5.1.4.1.1	$K_{12,5}$ Tension : -20°C, 23°C, 80°C	6.1.4.1.1	Value expressing the secant stiffness at 12,5%, $K_{12,5}$ (see appendix 1) $R_{u,5} = X_{mean,n} - \tau_{\alpha\beta} . s$ for test at -20°C, +23°C, +80°C
5.1.4.1.2	Shear : -20°C, 23°C, 80°C	6.1.4.1.2	$R_{u,5} = X_{mean,n} - \tau_{\alpha\beta} \bullet s$ for test at -20°C, +23°C, +80°C <u>For tension and shear</u> : $\Delta X_{mean} = X_{mean\ -20°C}/X_{mean,n\ 23°C} \geq 0,75$ $\Delta X_{mean} = X_{mean\ 80°C}/X_{mean,n\ 23°C} \geq 0,75$ Rupture $\geq$ 90% cohesive
5.1.4.2 Residual Strength after artificial ageing			
5.1.4.2.1	Immersion in hot water	6.1.4.2.1	The minimum requirement is 1000 hours immersion 1) $\Delta X_{mean} \geq 0,75$ test at +23°C 2) For the $0 \leq x \% \leq 12,5$ of the deformation/stress curve (see appendix 1) the stiffness must be as follows: $0,5 \leq K_{x,c}/K_x \leq 1,10$ Rupture $\geq$ 90% cohesive
5.1.4.2.2	Humidity and NaCL	6.1.4.2.2	$\Delta X_{mean} \geq 0,75$ test at +23°C - Rupture $\geq$ 90% cohesive
5.1.4.2.3	Humidity and SO_2	6.1.4.2.3	$\Delta X_{mean} \geq 0,75$ test at +23°C - Rupture $\geq$ 90% cohesive
5.1.4.2.4	Facade cleaning Products	6.1.4.2.4	$\Delta X_{mean} \geq 0,75$ test at +23°C - Rupture $\geq$ 90% cohesive
5.1.4.2.5	Materials in contact	6.1.4.2.5	*Method without UV* : Neither discoloration nor effect on $R_{u,5}$ is permitted - Rupture : 90% cohesive *Method with UV* : After exposure, the compatibility is determined by observation for discoloration with normal corrected vision Peel test requirement : no adhesion ruptures permitted during the peel test
5.1.4.3 Retaining Devices			
5.1.4.3.1	Mechanical self-weight support	6.1.4.3.1	The load is noted at which a maximum deflection is produced between A and B of 0,5 mm.
5.1.4.3.2	Anchorage	6.1.4.3.2	*Method I* : Calculated value : Static : $F_{u,5\ static} = F_{mean} - \tau_{\alpha\beta} . s$ and $F_{des} = F_{u,5} / \tau$ Dynamic : the 5350 cycles shall be passed without damage for the 5 anchorages tested *Method II* : $P_{br,c}/ P_{br,n} \geq 0,75$ $F_{des} = P_{br,n} x a^2/ 4 x\tau$
5.1.4.3.3	Safety devices	6.1.4.3.3	The variety of designs is such that the approval body will decide upon a relevant approach.
5.1.4.4	Opening Lights	6.1.4.4	After the test, no damage to the structural sealant shall be evident.The windows shall be examined before, during and after the tests noting the appearance of any defects, for example glazing breakage, detachment, etc.
5.1.4.5	Impact tests	6.1.4.5	The performance is analysed using UEAtc [3] guideline "Light Cladding", Title III, chapters 1,2 and 1,3 No performance determined option is possible.

T A B L E 8.3 - **ER4**
(contd)

Reference	Verification Methods	Reference	Treatment of results and requirements - Criteria
5.1.4.6 Test on Structural Sealant			
5.1.4.6.1	Gas Inclusions	6.1.4.6.1	No visible gas bubbles allowed using normal corrected vision
5.1.4.6.2	Elastic recovery	6.1.4.6.2	The elongation after 24 h. after unloading shall be < 5 % of the initial elongation.
5.1.4.6.3	Shrinkage	6.1.4.6.3	The shrinkage shall be less than 10 %.
5.1.4.6.4	Resistance to tearing	6.1.4.6.4	$\Delta X_{mean} \geq 0{,}75$
5.1.4.6.5	Mechanical fatigue	6.1.4.6.5	$\Delta X_{mean} \geq 0{,}75$; Rupture ≥ 90% cohesive
5.1.4.6.6	U.V resistance of the sealant	6.1.4.6.6	$\Delta X_{mean} \geq 0{,}75$ for elongation and breaking stress
5.1.4.6.7	Elastic modulus of the sealant	6.1.4.6.7	Declared value resulting from the test As a function of type of curve obtained (a,b,c,d following Figure 1 of ISO 527) the following pairs of value will be given $(\varepsilon_1, \sigma_1)$, $(\varepsilon_2, \sigma_2)$, $(\varepsilon_m, \sigma_m)$, $(\varepsilon_y, \sigma_y)$, $(\varepsilon_B, \sigma_B)$ The calculation modulus : $E = \frac{\sigma_2 - \sigma_1}{\varepsilon_2 - \varepsilon_1}$
5.1.4.6.8	Creep under long-term shear and cyclic tensile loading	6.1.4.6.8	For all the samples, 24 hours after unloading, the maximum relative horizontal displacement is 0,1 mm . the movement must be stabilised after 91 days . the maximum movement measured before unloading must be compatible with that which the system can accommodate. - “e” (see fig. 17) is the maximum authorised structural seal width
5.1.4.8	Sill heights	6.1.4.8	The range of possible sill heights is noted.
5.1.4.9	Wind resistance	6.1.4.9	Classification following the UEAtc guideline Windows. The maximum deflection of the prototype is to be mentioned in the ETA.
5.1.4.10	Behaviour in fire (see also ER2)	6.1.4.10	Classification according to CEN classification document.

TABLE 8.4 - **ER5 and ER6**

Reference	Verification methods	Reference	Treatment of results and requirements - Criteria
ER5 Protection against noise			
5.1.5	Protection against noise	6.1.5	The applicant shall declare the performance level claimed Rating of sound insulation and result presentation : EN 717-1 No performance determined option is possible.
ER6 Energy economy and heat retention			
5.1.6.1	Thermal insulation	6.1.6.1	Aggregate method: The results are expressed in accordance with 7.3 and 8 of prEN 12412. No performance determined option is possible.
5.1.6.2	Air permeability	6.1.6.2	see 6.1.3.1 No performance determined option is possible.

TABLE 8.5 - **Durability aspects**

5.1.7 Durability aspects
It is assumed that the whole testing programme is necessary and sufficient to assess durability.

TABLE 8.6 - **Verification methods related to the identification of the products**

Reference	Verification methods	Reference	Treatment of results and requirements - Criteria
Verification methods related to the identification of the products			
5.2.1 Structural sealant			
5.2.1.1	Specific mass	6.2.1.1	V_{mean} and S
5.2.1.2	Hardness	6.2.1.2	V_{mean} and S
5.2.1.3	Thermogravimetric analysis	6.2.1.3	Thermogravimetric curve
5.2.1.4	Colour	6.2.1.4	Colour scale ISO 4660
5.2.2 Anodised aluminium structural adhesion surface			
5.2.2.1	Alloys of aluminium	6.2.2.1	Chemical composition :The alloys of aluminium commonly used in architecture for this type of application are alloys EN AW-6060 and EN AW-6063 to EN 573-3, part 3. Other alloys may be used provided they meet the relevant requirement of this Guideline
5.2.2.2	Characteristics of the anodising		
5.2.2.2.1	Measurement of the thickness	6.2.2.2.1	Minimum average thickness 15 μm
5.2.2.2.2	Sealing tests	6.2.2.2.2	For ISO 2143: The values 0-2 on the EWAA/EURAS scale are acceptable For ISO 3210: Maximum weight loss 30 mg/dm^2 For ISO 2931: the admittance < 20 μS If the anodising on the aluminium alloy has a QUALANOD mark corresponding to the requirements above it may be taken into account by the Approval Body
5.2.2.2.3	Measurement of the admittance at 20000 Hz	6.2.2.2.3	Reference value measured at 20000 Hz for the given anodising thickness (see also 8.1.4.2.1).
5.2.2.3 Description of the anodising process			
5.2.2.3.1	Scouring	6.2.2.3.1	no criteria, description
5.2.2.3.2	Anodic oxidation	6.2.2.3.2	no criteria, description
5.2.2.3.3	Sealing of the anodised layer	6.2.2.3.3	no criteria, description
5.2.3 Glass adhesion surface			
5.2.3.1	Identification of the glass	6.2.3.1	Relevant prEN for the type of glass
5.2.3.2	Glass product	6.2.3.2	Criteria for the relevant set of tests applicable, see 5.1.4 and 5.2.3.2.
5.2.3.3	Coated glass	6.2.3.3	Only glass coatings A,B,S to prEN 1096 are suitable for structural bonding. In addition, the glass coating must meet the requirement of the relevant set of tests applicable, see 5.1.4 and 5.2.3.3.
5.2.4 Stainless steel adhesion surface -			
	Stainless steel alloy	6.2.4	Stainless steel material shall be austenitic alloy, reference X5CrNi18-10 and X5CrNiMo17-12-2 to EN 10088 (304 and 316, following AISI ASTM) in a condition suitable for bending or welding. Only the tested surface finish can be actually used in practice.

6.2 Hygiene, Health and the environment

6.2.1. Release of dangerous substances

The product/kit shall comply with all relevant European and national provisions applicable for the uses for which it is brought to the market. The attention of the applicant should be drawn on the fact that for other uses or other Member States of destination there may be other requirements which would have to be respected. For dangerous substances contained in the product but not covered by the ETA, the NPD option (no performance determined) is applicable.

7 Assumptions under which fitness for use is to be assessed

7.0 General

Chapter 7 sets out the preconditions for design, execution, maintenance and repair which are an assumption for the assessment of the fitness for use according to the Guideline (only when necessary and where they have a bearing on the assessment or the products).

In making an assessment of the fitness for use of an SSG system, it is necessary to consider the system in relation to existing codes of practice for installation, particularly those for glass and glazing. Where particular features of the system and, in particular, the site installation procedure, are unusual and outside the scope of existing codes, these features must be noted in the ETA and details given of the precautions necessary on site, to ensure correct installation and therefore the required level of performance.

An overall assumption is made that surfaces deemed suitable for structural bonding will not be rendered unsuitable by unapproved actions during processing, for example, the application of lanolin subsequent to anodising of aluminium is not acceptable.

7.1 Design of the works

The design of a facade, incorporating an SSG system, in many important respects, will be specific to the building on which it is to be used.

This includes the overall structural performance of the facade, its impact resistance, acoustic performance (where relevant), and hygrothermal behaviour.

The ETA for the SSG system will indicate the thermal properties of elements of the SSG system and will give guidance on likely acoustic behaviour. It is to be assumed that specific calculations and, in some cases, tests will be necessary for each application. Similarly, calculations and, if necessary, tests will be required to determine the overall structural adequacy of the facade and that of the structure to which the SSGS components are attached. It is for the specifier to ensure that the facade as installed in the building will provide the required performance on basis of the information given in the ETA.

For a facade incorporating the SSGS to perform its function, it is necessary for the facade structure to meet the preconditions defined in the ETA (see Chapter 9). The following list gives likely pre-conditions but the list is not exhaustive and can be adapted to particular systems:

- there will be a limit on the acceptable deflection of mullions and transoms
- the joint between mullions and transoms in the facade structure must resist, without deterioration or permanent deflection, the operational loads and the dead weight of the sealant support frame and the glazing
- the facade structure shall be equipped with expansion joints and be electrically earthed
- the maximum calculated deflection of the structural sealant support frame without glass, between two adjacent anchorages on the same edge (see terminology clause 3.2.01), is 1/300 (see also 5.1.4.7).

Where a no performance determined option applies to a kit, the performance requirement can be met by the adoption of other suitable measures.

7.2 Execution of the works

7.2.1 Transport and storage

The approval body shall check that the manufacturer takes suitable precautions during transport and storage to ensure that glazed sealant support frames are protected against damage by, e.g. breakage, scratching, spalling or contamination.

Suitable arrangements have to be made to prevent the application of unacceptable loads to the structural seal, for example the provision of suitable racks, and to prevent exposure to water, solar radiation or significant changes of temperature, by protecting with covers.

7.2.2 Installation

7.2.2.1 General

The supplier of the SSG system must provide detailed instructions regarding fixing of the glazed sealant support frame to the facade structure, including the procedure for precise alignment of the units and subsequent weatherproofing.

The installation of the SSG system must be practicable under normal site conditions. It is a requirement of this Guideline that all structural bonds are made in a factory under well-controlled conditions. However, taking account of this important requirement, it is still possible for the long-term integrity of the structural bond to be affected by poor installation. This problem is more likely to arise where the site process is difficult, requiring an unusually high level of skill and training.

An examination shall be made, by the approval body, of the site fixing instructions or advisory arrangements provided by the SSG system supplier. The purpose of this examination is to ensure that the instructions are adequate to allow installation by site operatives using normal levels of skill, with some special training as required. It is to be expected that certain aspects will always be covered in the instructions, for example, comment on the need to prevent blockage of drainage apertures when applying a weathering sealant, ensuring correct positioning of safety devices to avoid concentrated loads on glazing, and the requirements for correct lifting of units.

During the assessment, it must be determined whether the design of the system presents particular difficulties for site installation. The assembly of the samples for air-leakage, windload and water-leakage testing presents a suitable opportunity for an assessment to be made.

There are a number of design aspects requiring particular attention for ease of installation. The following notes draw attention to some of these, but the list should not be considered to be exhaustive:

i Site fixing of the mechanical support for glass self-weight.

ii Site placing of setting blocks [usually in conjunction with i].

The sequence of installation (particularly the fitting of setting blocks) must not allow undue shear stress to be applied to the structural bond.

iii Dimensional tolerances of interconnecting elements.

iv Site fixing of safety devices.

7.2.2.2 Weathersealing

The requirements for weathersealing will vary depending on the type of system used. Where a sealant is used, it will normally be necessary to thoroughly prepare the sealing surfaces, apply a primer where specified, insert any backer-rod and seal with the specified sealant.

Where a preformed gasket is to be used it will be necessary to ensure that the gasket aperture in the facade is clean and that the tolerances on its dimensions are within the specified limits.

Variations on these procedures must be examined to ensure that the required performance will be achieved and that the procedure is practicable on site.

7.3 Maintenance and repair

It will be necessary to examine the manufacturer's recommendations for the frequency of cleaning and maintenance of the facade and the method to be used.

The procedure for cleaning shall allow only the use of those products assessed as compatible with the SSGS components. The use of non-abrasive cleaning tools may be acceptable if no damage to a coating on glass side 1 will result.

Due to the difficulty of quality control during on site repair, a factory-glazed replacement frame must be installed. Therefore, it is necessary to make an assessment and to comment on the ease of future replacement.

Replacement of weatherseals should be undertaken using procedures and materials approved by the SSGS supplier and covered by the ETA.

SECTION THREE : ATTESTATION OF CONFORMITY

8 Evaluation of conformity

8.1 EC decision

The systems of attestation of conformity specified by the European Commission detailed in EC Mandate are as follows [Commission decision of 24/06/96, published in the EC Official Journal L254 of 08/10/96].

System 1 (without audit testing of samples) for SSG kits, Types II and IV.

System 2+ [first possibility, including certification of the factory production control (FPC)] by an approved body on the basis of its continuous surveillance, assessment and approval for SSG kits Types I and III. [The systems being as described in Council Directive 89/106 EEC, Annex III.2.(i) and (ii) respectively].

System 1

a. tasks for the manufacturer

- factory production control
- testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan.

b. tasks for the approved body

- initial type testing of the product
- initial inspection of the factory and of factory production control
- continuous surveillance, assessment and approval of the factory production control.

System 2+

a. tasks for the manufacturer

- initial type testing of the product
- factory production control.

b. tasks for the approved body

- initial inspection of the factory and factory production control
- continuous surveillance, assessment and approval of the factory production control.

In practice, the operation of systems 1 and 2+ will be very similar for SSG kits, for the following reasons:

a. the results of testing will normally be available as part of the work required for the assessment of the products for ETA and these tests should be used for the purposes of initial type testing

b. the nature of the product is such that testing of samples taken at the factory by the manufacturer will be required under the FPC arrangements.

The significant differences between the two systems are as follows:

a. the system of qualification of the approved bodies involved in initial inspection of the factory/FPC and continuous surveillance will be different for the two systems (see EC Construct 95/149, Guidance Paper A)

b. A Certificate of Conformity of the product from an approved body will be required for system 1, and a certification of FPC for system 2+.

8.2 Responsibilities

8.2.1 Tasks for the manufacturer

8.2.1.1 Factory production control

The manufacturer shall exercise permanent internal control of production. In the context of the SSG kit, the term manufacturer relates to the company responsible for putting the kit on the market (normally this is also the ETA holder). All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner as written policies and procedures. This production control system shall ensure that the product is in conformity with the European Technical Approval (ETA).

Manufacturers having a FPC system complying with EN ISO 9001/2 and addressing the requirements of an ETA are recognised as satisfying the FPC requirements of the Directive.

8.2.1.2 Testing of samples taken at the factory — Prescribed Test Plan

This relates only to taking samples representative of the final product. In the context of SSGS, the testing of "H" pieces and peel tests, as part of FPC, provide the necessary evidence.

8.2.1.3 Declaration of Conformity (System 2+)

When all the criteria of the conformity attestation are satisfied, the manufacturer shall make a Declaration of Conformity.

8.2.2 Tasks for the manufacturer or the approved body - Initial type testing

Approval tests will have been conducted by the approval body or under its responsibility (may include a proportion conducted by an indicated laboratory or by the manufacturer witnessed by the approval body) in accordance with Chapter 5 of this ETAG. The approval body will have assessed the results of these tests in accordance with Chapter 6 of this ETAG, as part of the ETA issuing procedure. These tests should be used for the purposes of Initial Type Testing.

For System 1, this work should be validated by the approved body for Certificate of Conformity purposes. For System 2+, the work should be taken over by the manufacturer for Declaration of Conformity purposes.

8.2.3 Tasks for the approved body

8.2.3.1 Assessment of the factory production control system — initial inspection only or initial inspection and continuous surveillance

Assessment of the FPC is the responsibility of an approved body.

An assessment must be carried out at each manufacturing step of each manufacturing plant to demonstrate that the factory production control is in conformity with the ETA and any subsidiary information. This assessment shall be based on an initial inspection of the factory.

Subsequently continuous surveillance of factory production control is necessary to ensure continuing conformity with the ETA.

It is recommended that surveillance inspections be conducted <u>at least</u> twice per year.

8.2.3.2 Certification

The approved body shall issue Certification of Conformity of the product (for System 1) or shall issue Certification of the Factory Production Control System (for System 2+).

8.3 Documentation

8.3.1 General

The approval body issuing the ETA shall supply the information detailed below. This information and the requirements given in EC Guidance Paper B (Construct 95/135 Rev 1), will generally form the basis on which the factory production control (FPC) is assessed by the approved body :

(i) the ETA
(ii) basic manufacturing process
(iii) product and materials specifications
(iv) test plan as part of FPC
(v) other relevant information.

This information shall initially be prepared or collected by the approval body and shall be agreed with the manufacturer. The following details give guidance on the type of information required :

8.3.2 Detailed documentation

8.3.2.1 The ETA

See section 4 of this Guideline.

8.3.2.2 Basic manufacturing process

The basic manufacturing process shall be described in sufficient detail to support the proposed FPC methods.

Normally, the correct handling, storage and pre-treatment of SSGS components is critical. Specific requirements should be emphasized when the manufacturing process is described.

8.3.2.3 Product and materials specifications

Product and materials specifications will be required for the various components, many of which will be bought-in. The information required may take a number of forms, and may include :

- detailed drawings (including manufacturing tolerances)
- declaration on raw materials specifications
- references to appropriate specifications
- manufacturers data sheet.

8.3.2.4 Test plan as part of FPC

The manufacturer and the approval body issuing the ETA shall agree a test plan (CPD Annex III 1b).

An agreed test plan is necessary as current standards relating to quality management systems (Guidance Paper Number B, EN 29002, etc) do not ensure that the product specification remains unchanged and they cannot address the technical validity of the type or frequency of checks/tests.

The validity of the type and frequency of checks/tests conducted during production and on the final product shall be considered. This will include the checks conducted during manufacture on properties that cannot be inspected at a later stage and for checks on the final product. These will normally include:

- Checks on incoming material

The documentation shall make it obvious that the incoming materials correspond to those listed in the ETA.

Where incoming material or components are manufactured and tested by the supplier in accordance with agreed methods, then further testing by the SSG kit manufacturer is not normally necessary. If the supplier does not make such tests, then the kit manufacturer must make appropriate checks/tests before acceptance.

(i) On each batch of sealant (production in one run which can involve several barrels)

Adhesion-cohesion under tension to rupture on float glass and on a reference metal (aluminium or stainless steel).

Six test pieces, in accordance with Figure 6, are made and stored according to the structural sealant manufacturer's instructions.

These three test pieces are then subjected to a tensile test to rupture.

The three remaining test pieces are immersed in water at 95 ± 2°C for 24 hours. They are then conditioned for 48 ± 4 hours at a temperature of 23 ± 2°C and 50 ± 5 % relative humidity. These test pieces are then subjected to the tensile test to rupture.

T A B L E 9 - Treatment of results and requirements

Tests	Treatment of results and requirements
Adhesion-cohesion under tension to rupture before and after immersion in water	Rupture 90 % cohesive Rupture value to be checked and noted. The minimum breaking value is to be given by the sealant manufacturer in the defined test conditions (T°, RH, …).

(ii) On each batch of anodised aluminium (e.g. group of aluminium profiles anodised in the same bath at the same time)

Five electrical measurements of the admittance and the thickness per batch of the anodising will demonstrate the consistency and the conformity to the ETA of the anodisation of one bath, and between several baths:

Method for characterising surface properties of the anodised aluminium layer:

Two properties have been selected to check stability of anodised aluminium profiles :

- the thickness of the aluminium oxide layer
- the level of sealing, i.e. the level of porosity of the surface.

The thickness of the aluminium oxide layer is measured using the eddy current method.

Level of sealing is determined by measuring the admittance of the oxide layer at high frequency (20 kHz).

Note : for the other types of substrate (stainless steel, glass, ...), no test equivalent to (ii) is necessary.

(iii) on stainless steel

The certificate provided by the stainless steel producer is used to establish that the stainless steel product supplied for the project is identical to the product described in the ETA (the alloy and the surface finish). No specific test is required. If necessary, the approved body can request the relevant performance report from the initial type testing.

(iv) on glass

No specific test is required.

(v) on coated glass

No specific test is required. The technical file accompanying the coated glass delivery shall include a declaration that the coated glass is manufactured in accordance with the classes A, B, S of the prEN 1096 series.

(vi) on insulating glass units

No specific test by the ETA holder is required.

However, he shall communicate the IGU specifications to the supplier so that IGU's can be manufactured in accordance with the ETA, giving at least the following information:

where the outer edge seal has no structural function :

- the list of the IGU sealant(s) compatible with the SSGS kit,
- the dimensional tolerances (in relation with the essential requirements) applicable to the IGU,
- essential characteristics, deviation from prEN 1279-1,
- …

additional information where the outer edge seal has a structural function:

- $R_{u,5}$, the characteristic breaking stress of the IGU structural sealant(s),
- Dimensions and tolerances of the bite of the structural edge seal or the detailed calculation method for the bite of the structural edge seal, the permissible tolerance on it and the value of the variable to be used in the calculation method.
- the list of coatings to which the structural edge sealant can be applied (on faces 2, 3 of the IGU)
- the list of the coatings to which the structural sealant can be applied (on stepped IGU face 2, non-stepped IGU face 4),
  others, …

The technical file accompanying the IGU delivery shall include:

- a declaration that the IGUs are manufactured in accordance with the prEN 1279 series
- a declaration that the IGUs are manufactured in accordance with ETA specifications given by the ETA holder:

additionally, where the outer edge seal has a structural function:

a summary of the test records collected during the factory production control of the IGU:

The test programme shall either conform to Table 10 (Table 10, point 3, in this case not relevant), or the test programme shall be as described in prEN 1279-6, annex f - 1997 with the following modifications:

- sample

geometry: described in prEN 1279-6, annex f, Fig. F.2, "glass, glass sample"
the glass samples shall be coated as for the project in hand.

- the test procedure: prEN 1279-6, annex f, § F.3.3, shall be modified as follows:

the tensile test shall be continued until rupture of the sample.
Minimum requirement: rupture 90% cohesive.
Rupture value to be checked and noted. The minimum breaking value must be given by the sealant manufacturer in defined test conditions (T°, RH, …).
Special delivery conditions may demand that the requirement given above be fixed at a higher level.

- Frequency: Three samples in the morning, three in the afternoon and three samples at each packaging change.

- Checks during the application of structural sealant.

TABLE 10 - Checks necessary over a two-days cycle of production

Company:			Project name:		Production date :
	First day; third day; fifth day		Second day; fourth day, sixth day		
	morning	afternoon	Morning	afternoon	packaging change
1. General extrusion machine cleaning (1)	reference to cleaning solvent	not applicable	not applicable	not applicable	reference to cleaning solvent
temperature (°C)	value	value	Value	value	not applicable
relative humidity (%)	value	value	Value	value	not applicable
2. Structural sealant Silicone lot number for 2 comp, base + Catalyst	reference	not applicable	Reference	not applicable	reference
base / catalyst ratio (1), (3)	ratio value	ratio value	Ratio value	ratio value	ratio value
glass plate (marble) test (1), (2)	pass/fail	pass/fail	Pass/fail	pass/fail	pass/fail
3. Metal type lot number surface finishing	 alloy reference type	 not applicable not applicable not applicable	 not applicable not applicable not applicable	 not applicable not applicable not applicable	 alloy reference type
cleaning product name and lot number	reference	not applicable	not applicable	not applicable	reference
if any - primer name and lot number	reference	not applicable	not applicable	not applicable	reference
4. Glass surface finishing (5)	coating reference	not applicable	not applicable	not applicable	coating reference
cleaning product name and lot number	reference	not applicable	not applicable	not applicable	reference
if any - primer name and lot number	reference	not applicable	not applicable	not applicable	reference
5. Adhesion testing on H - pieces (4) sample 1 curing time: … rupture ≥ 90 % cohesive rupture ≥ 100 % cohesive tensile strength (N)	**H - pieces (4)** value pass/fail not applicable value	Peel-test (6) on glass value not applicable pass/fail not applicable	Peel-test (6) on glass value not applicable pass/fail not applicable	Peel-test (6) on glass value not applicable pass/fail not applicable	H pieces (4) value pass/fail not applicable value
sample 2 curing time: … rupture ≥ 90 % cohesive rupture ≥ 100 % cohesive tensile strength (N)	 value pass/fail not applicable value	on metal value not applicable pass/fail not applicable	on metal value not applicable pass/fail not applicable	on metal value not applicable pass/fail not applicable	 value pass/fail not applicable value
sample 3 curing time: … rupture ≥ 90 % cohesive rupture ≥ 100 % cohesive tensile strength (N)	 value pass/fail not applicable value	not applicable	not applicable	not applicable	 value pass/fail not applicable value

(1) Only for two-component silicones

(2) The glass plate (marble) test is used to check the homogeneity of the mixture.

A quantity of silicone product (mixed by the pump) is placed on one glass plate and squeezed by placing a second glass plate on top. Whenever grey or white traces are visible, this indicates that mixing is not sufficient and bonding must not commence until further mixing and a successful glass plate test have been undertaken.

(3) All two-component mixing equipment incorporates two tubes where small quantities of base and catalyst can be taken to check that the actual mix ratio complies.

(4) The H pieces are test pieces of silicone (12 x 12 x 50 mm) between two substrates. The samples must be made with the products actually used in the project (metal and surface finishing, glass and coating, structural sealant). The coated glass manufacturer shall furnish the bonding company with the necessary samples in order to allow the bonding company to perform the tests in accordance with Table 10.

The shaping of the test-pieces can be assisted by e.g. wooden blocks treated with a soap solution to avoid adhesion of the silicone or with spacer tape with release paper retained in place. With one component sealant, it must be ensured that spacers are not air and vapour tight otherwise the curing of the silicone can be prevented.

The H test pieces are subjected to tensile test to rupture. The minimum breaking value is to be given by the sealant manufacturer. As soon as the first H test piece has given a satisfactory result, the remaining test pieces are not tested and stored for eventual further testing.

(5) Where a special type of coated thermally- or heat-strengthened glass is prescribed in the project specifications, the glass manufacturer shall furnish the bonding company with the necessary samples of coated float glass for the purposes of testing in accordance with Table 10.

(6) Peel test description

The peel test samples must be made with the products actually used in the project (metal and surface finishing, glass and coating, structural sealant). The coated glass manufacturer shall furnish to the bonding company the necessary samples in order to allow the bonding company to perform the tests in accordance with Table 10.

The peel test samples are made as follows (see Figure 19):

> Two short pieces of bond breaker are placed on the substrate a distance of 200mm apart. A bead of structural sealant of about 25 x 6 x 250 mm in length is extruded between the bond breakers in accordance with Figure 19.

The peel test samples shall be stored in the same environmental conditions as the manufactured elements during production. After the minimum curing time given by the manufacturer, the structural sealant bead is peeled as follows:

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

The failure pattern is assessed. 100% cohesive failure is required (adhesive failure is not acceptable - see Figure 20).

A peel test can always be replaced by tests on H pieces (see point (4) above).

8.3.2.5 Checks on assembled SSG elements

The list of checks given below is not exhaustive and can be adapted in each individual case:

- Visual inspection of the finished element (verification that gas inclusions are not present)
- Checks on the joint dimensions
- Glass assembly as a function of the specification
- Relative position of the bonded element
- Correct provision of drainage/pressure equalisation as required by the specification

- Correct fixing of mechanical devices
- Correct provision and placing of spacers, where these are factory-fitted.

Where materials/components are not manufactured and tested by the supplier in accordance with agreed methods, then, where appropriate, they must be subject to suitable checks/tests by the manufacturer before acceptance.

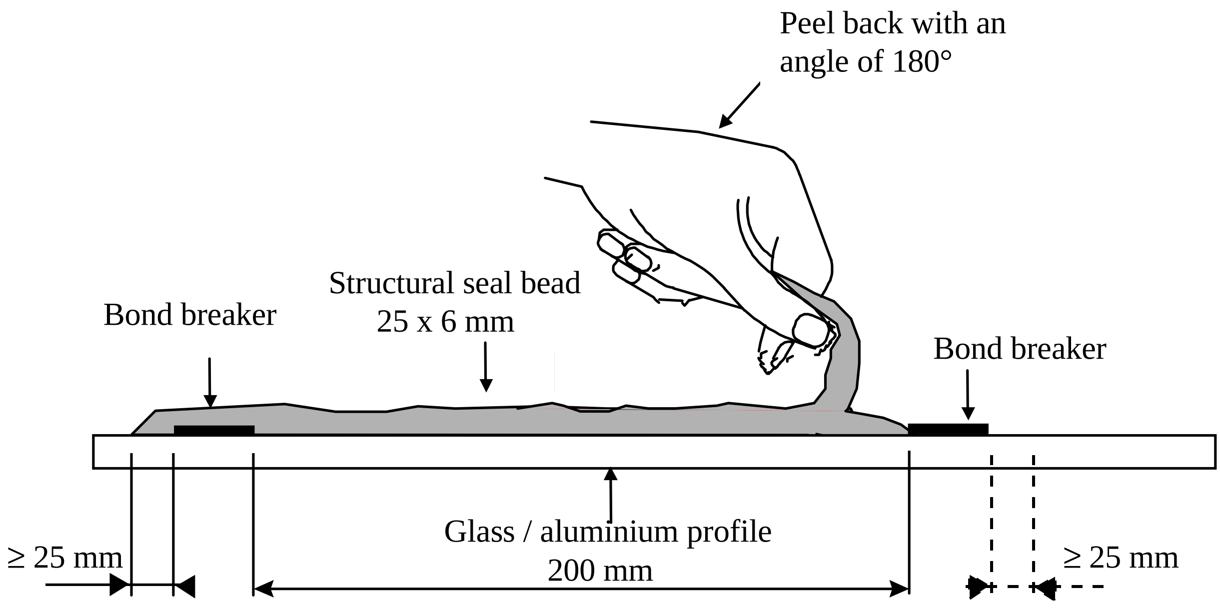


Figure 19 - Peel test description

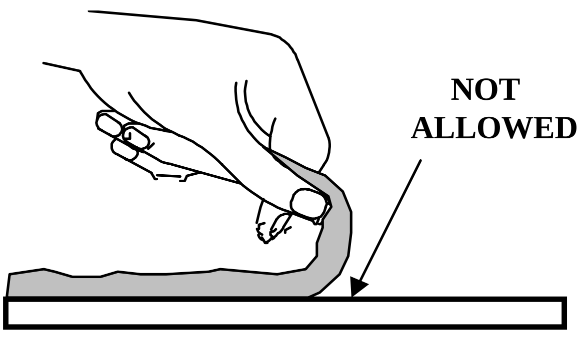


Figure 20 - Unacceptable failure pattern

8.4 CE marking and information

According to the CPD, Annex III, paragraph 4 (EC certificate or EC declaration according to the provisions of the mandate).

Indicate marking and labelling and further information (content and format) to be given by the manufacturer in addition to the ETA publication and in conformity with CE Guidance Paper D on CE marking.

SECTION FOUR : ETA CONTENT

9.1 ETA contents

The format of the ETA shall be based on the Commission Decision of 22/7/97 - EC Official Journal L236 of 27/08/97.

For an SSG kit the following information shall be provided as a minimum:

9.1.1 Performance

- The SSGS type (reference Section One, 2.1).
- Reaction to fire and resistance to fire.
- Use categories (where relevant) in relation to low temperatures.
- Performance characteristics in relation to wind resistance, airtightness and watertightness, behaviour in fire, thermal performance, impact resistance, acoustic performance and release of dangerous substances.

No performance determined options are possible for some of these characteristics (see Tables 8.1 to 8.6).

9.1.2 Specification

The ETA shall show a horizontal and vertical cross section of a typical assembly and shall contain, as a minimum, the following details of the SSG kit.

9.1.2.1 Dimensions

The following dimensions shall be given together with tolerances where relevant.

- for the glass

  thickness and maximum overall dimensions with tolerances including flatness

- for IGUs

  the glass details (as above) and the unit width.

- for the sealant support frame

  external dimensions, with tolerances on squareness, flatness and straightness of members.

- for the module formed by transoms and mullions

  external dimensions, with tolerances on squareness

- for all metal sections and preformed sealing profiles

  cross section details and major dimensions

- for the assembled kit

  centre-to-centre distance between anchorages of the structural sealant support frame to the facade structure.

9.1.2.2 Components and accessories

The following general details of the major component and accessory specifications shall be given in the ETA.

- structural sealant
  - the manufacturer and type designation.
  - the instructions for applying the sealant, in particular
    working time
    skin-over time and tack-free time
    time before handling
  - mechanical characteristics ($R_{u,5}$; σ_{des}; τ_{des}; τ_{∞}; E_o; ...).
- glass
  - information necessary for identification (standard references, etc)
  - where relevant, details of coatings by layers and for IGUs by surface.
- aluminium and anodising / stainless steel and surface finishes
  - the designation of the aluminium or the metallic alloy
  - the characteristics of the anodising or of the surface finishing.
- weatherseal
  - identification of the material used (gasket, sealant, etc)
  - cross section in the case of a pre-formed gasket.
- backer rod

  identification of the material used.
- spacer

  identification of the material.
- setting and location blocks
  - type of material
  - shore hardness.
- mechanical self-weight support

  description of geometry and materials used.
- anchorage of the sealant support frame to the facade

  description of geometry and materials used.
- retaining devices (where used)

  description of geometry and materials used.
- opening-light hardware
  - general type details
  - type of material and protection against corrosion.

In addition to the above, the ETA shall contain details of the approach used in calculating the structural seal and give the minimum permissible dimensions.

The ETA shall also contain any details of the installation which the approval body considers worthy of note, as described in Chapter 7 of this Guideline, and details of the maximum acceptable deflection in the facade structure.

9.1.3 Dangerous substances.

In section II.2 characteristics of products and methods of verification the ETA shall include the following note:
“In addition to the specific clauses relating to dangerous substances contained in this European Technical Approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.”

9.2 Additional information

9.2.1 Content of the ETA technical file to be available to other Approval Bodies (in addition to the information in the ETA).

9.2.1.1 Structural sealant

The file shall contain the following information :

- reports of tests required, following the details in Tables 8.1 to 8.6
- the identification of the cleaning products tested according to 5.1.4.2.4
- manufacturer's specifications regarding application of the sealant.

If the hermetic seal of the insulating unit acts as a structural seal, the same information as stated above is to be given regarding the silicone sealant of the hermetic seal.

9.2.1.2 Glass

For the glass used to perform the tests described in clauses 5.1.4.1, 5.1.4.2 and 5.1.4.6, the file shall contain the following information:

- reports of the tests required, following the details in Tables 8.1 to 8.6.

9.2.1.3 Aluminium and anodising

For the aluminium used to perform the tests mentioned in clauses 5.1.4.1, 5.1.4.2 and 5.1.4.6, the file shall contain the following information:

- the characteristics of the anodisation, required in clause 5.2.2
- the shape of the aluminium adhesion surface
- certificate of production under the Qualanod label
- the name of the anodising firm
- the name of the primer and cleaning product applied before bonding
- reports of tests required following Tables 8.1 to 8.6.

9.2.1.4 Weather seal

- if applicable, the reports of materials compatibility in accordance with par. 5.1.4.2.5
- report of compatibility with the cleaning product(s)
- the necessary test report or the justification of fitness for use for the product in the particular SSGS (see clause 4.8).

9.2.1.5 Backer rod

- if applicable, the reports of the materials compatibility tests in accordance with par. 5.1.4.2.5
- the necessary test report or the justification of fitness for use for the product in the particular SSGS (see clause 4.8).

9.2.1.6 Spacer

- if applicable, the reports of the materials compatibility tests in accordance with par. 5.1.4.2.5
- identification of the material
- the necessary test report or the justification of fitness for use for the product in the particular SGSS (see clause 4.8).

9.2.1.7 Setting and location blocks

- if applicable, the reports of the materials compatibility tests in accordance with par. 5.1.4.2.5.

9.2.1.8 Mechanical self-weight support

- if applicable, the reports of the bearing capacity test in accordance with par. 5.1.4.3.1
- if applicable, a calculation of the bearing capacity.

9.2.1.9 Anchorage of the sealant support frame on the facade structure

- if applicable, the reports of the bearing capacity test in accordance with par. 5.1.4.3.2
- if applicable a calculation of the bearing capacity.

9.2.1.10 Retaining devices

- description of the investigations made to ensure that the devices will not damage the glazing.

9.2.1.11 Opening light hardware

- basis for the acceptance of any components specifically covered by the ETA.

9.2.1.12 SSG kit

The file shall contain the following information:

- full description of the prototype used for whole system testing
- details for the accommodation of building movement
- handbook for construction and maintenance of the facade.

9.2.1.13 Stainless steel

- alloy
- surface finishing.

9.2.2 Supplementary information to be provided to approved bodies (together with a copy of the ETA) for the purposes of evaluation of conformity.

- details of the manufacturing process, noting particular points of importance
- details of components and suppliers, with standard references, where relevant (but excluding confidential details such as formulations)
- details of sub-contractors providing services, such as structural bonding.

9.2.3 Dangerous substances

In addition to the specific clauses relating to dangerous substances contained in this European Technical Approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.

ANNEX 1 - STIFFNESS

This annex describes the method of linearisation for the tension curves. It can be used for the elastic area of the material and for materials with a Poissons' ratio of about 0,5 (normal for sealants used in SSGS). The advantages of this method are:

- a higher accuracy for the modulus with a reduced number of test samples
- verifying the relationship between the tensile, compressive and shear stiffness of the same material
- a higher reliability of the application of the calculation models.

A typical curve of deformation under tension is shown in figure A1.1. This curve shows irregularities. Given the application of a certain amount of pre-stressing, the determination of the zero point can give rise to difficulties and affect the precision of the stiffness at different elongations. An improvement can be gained by linearising the curve in the elastic area of the structural sealant.

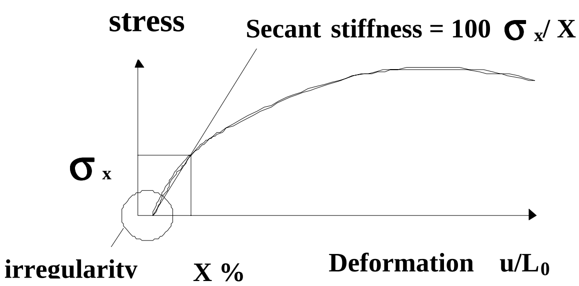


Figure A1.1 Secant stiffness

The linearisation is produced by a conversion of the deformation. For an initial length (L_0) of the test piece and the length of the loaded test piece (L, where $L = L_0$ + deformation), the scale for the deformation is expressed as :

$$\frac{u_c}{L_0} = \frac{(a - 1/a^2)}{3} \quad \text{where } a = L/L_0$$ [1]

When this technique is applied to several points of the curve, a converted line of regression stress/deformation, is obtained, the slope of which represents the tangent stiffness (K_0) at the origin.

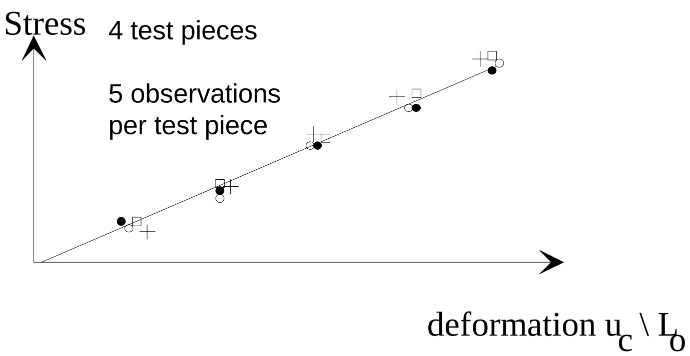


Figure A1.2 - Stress/deformation converted line of regression

[1] Paul Flory, Principle of polymer chemistry. Cornell Univ. Press, Ithaca, N. Y., USA (1953)

K_0 can be calculated directly from the measured points as follows :

$$K_o = \sum_{i=1}^{m} \sum_{I=1}^{n} \frac{K_{ij}}{m \times n} \quad \text{with} \quad K_{ij} = \frac{3 \times \sigma_{ij}}{a_{ij} - 1/a^2_{ij}} \; ; \; a_{ij} = \frac{e_i + u_{ij}}{e_i}$$

where :
m = number of observations per test piece
n = number of test pieces per test for the temperature concerned
u_{ij} = the displacement under tension or compression ($e_i + u_{ij}$ represents L)
e_i = the initial thickness per test piece representing L_0
σ_{ij} = the tensile stress at the tensile displacement u_{ij}.

The relationships between the tangent stiffness at the origin on one hand and the secant stiffness on the other are defined and given in Table A.1.

Table A.1

Conversion of the elongation relating to tension or displacement relating to compression (u/L_0) to values of converted deformation (u_c/L_0)	
u/L_0 values	**u_c/L_0 values = $(a - 1/a^2)/3$ ($a = L/L_0$)**
0	**0**
0,05	**0,048**
0,10	**0,091**
0,125	**0,112**
0,15	**0,131**
0,20	**0,169**
0,25	**0,203**
0,30	**0,236**
0,35	**0,267**
0,40	**0,297**
0,45	**0,325**
0,50	**0,352**
0,55	**0,378**
0,60	**0,403**
0,65	**0,428**
0,70	**0,451**
0,75	**0,474**
0,80	**0,497**
0,85	**0,519**
0,90	**0,541**
0,95	**0,562**
1,00	**0,583**

The relationship between the secant stiffness and the tangent stiffness at the origin is:

$$K_{sec} = K_0 \times (u_c / L_0) / (u / L_0)$$

ANNEX 2 - METHOD OF CALCULATION

A2.0 Introduction

This calculation method is based on 7 years experience with silicone.
Nevertheless, an applicant can present another method of calculation based on simulation test or results of research. To permit the approval body to issue an ETA based on such an alternative method of calculation, full justification must be given. Confirmation tests, calculations and / or simulation can be required by the approval
body.

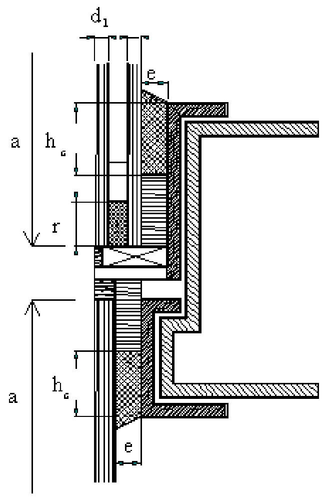


Figure A2 - Vertical section

A2.1 list of symbols

W	=	combined actions of the wind and the snow (Pa)
σ_{des}	=	tension design stress $\sigma_{des} = R_{u,5}/6$ ($R_{u,5}$ given in clause 6.1.4.1.1 (23 °C))
Γ_{des}	=	shear design stress under dynamic load $\Gamma_{des} = R_{u,5}/6$ ($R_{u,5}$ given in clause 6.1.4.1.2 (23 °C))
Γ_{∞}	=	shear design stress under permanent load $\Gamma_{\infty} = \Gamma_{des} / \gamma_c$ (see clause 5.1.4.6.8)
E	=	modulus of elasticity in tension of the silicone, given by the test 5.1.4.6.7
Δ	=	the maximum thermal movement, as a combination of the elongation in directions a and b

a	=	short side dimension of the glass pane
b	=	long side dimension of the glass pane
h_v	=	glazing height = vertical dimension a or b
γ_{tot}	=	total safety factor γ_{tot} = 6
T_c	=	temperature of the metallic frame at the moment t
T_v	=	temperature of the glass at the moment t
T_0	=	temperature during silicone application
α_c	=	linear coefficient of thermal expansion of the structural sealant support frame
α_v	=	linear coefficient of thermal expansion of glass
e	=	thickness of the seal
ΔT	=	T_c - T_v = 25°C the case under consideration (see also 4.4.4.1)
h_c	=	bite, see also terminology
r	=	bite of the hermetic seal having a structural function
G	=	shear modulus G = E/3
P	=	glazing self weight
d_1	=	outer glass thickness of the IGU
d_2	=	inner glass thickness of the IGU
d	=	single glass thickness

A2.2 Assumptions

The normal stresses in the section of the structural sealant have a uniform distribution
$\sigma_{des} = \Gamma_{des}$

A2.3 Supported systems

A2.3.1 Determination of bite h_c

The stress at the centre of the longest side of the pane can be calculated as follows:

$$\sigma_{centre} = a\,W/2\,h_c \rightarrow h_c \geq |\, a\,W/2\,\sigma_{des} \,|$$

(h_c limits, see 5.1.4.7)

A2.3.2 Determination of the thickness e

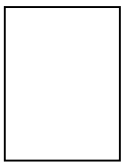
The thickness of the structural sealant is related to the design shear stress Γ_{des} (Pa) in the silicone

$$e = |\,(G \bullet \Delta) / (\Gamma_{des})\,|$$

e $\geq$ 6 mm is advisable

Value of Δ

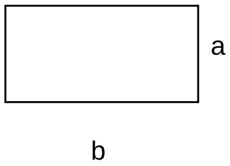
b > a the pane is supported at side a


b

$$\Delta = [(T_c - T_0).\alpha_c - (T_v - T_0).\alpha_v].\sqrt{(a/2)^2 + b^2}$$

a

b > a the pane is supported at side b



$$\Delta = [(T_c - T_0).\alpha_c - (T_v - T_0).\alpha_v].\sqrt{a^2 + (b/2)^2}$$

with the typical values :

T_c = 55°C
T_v = 80°C see also 4.4.5.1
T_0 = 20°C
$\alpha_c = 24.10^{-6}$ /K for aluminum
$= 12.10^{-6}$ /K for steel
$\alpha_v = 9.10^{-6}$ /K for glass

A2.3.3 Relation between h_c and e

Given the present stage of the knowledge, it is advisable to respect the following relationship:

$$e \leq h_c \leq 3e$$

A2.3.4 Calculation of the hermetic seal of the insulating unit working as a structural sealant

$$r \geq \frac{\beta \,.\, a \,.\, W}{2 \,.\, \sigma_{des}}$$

$$r \geq 6 \text{ mm}$$

ß is the part of the wind-load carried by the outer glass component

if $d_1 \leq d_2 \rightarrow$ ß $\simeq$ ½, then ß $\equiv$ ½

if $d_1 > d_2 \rightarrow$ ß > ½, then ß = 1

For small units or non-rectangular shapes climatical effects must be taken into account.

A2.4 Unsupported systems

A2.4.1 Determination of the thickness e

The thickness of the structural sealant is related to the design shear stress Γ_{des} (Pa) in the silicone

$$e = |(G \bullet \Delta) / (\Gamma_{des})|$$

$e \geq 6$ mm is advisable

A2.4.2 Value of Δ

$$\Delta = [(T_c - T_0).\alpha_c - (T_v - T_0).\alpha_v].\sqrt{(a/2)^2 + (b/2)^2}$$

with the typical values :

T_c = 55°C
T_v = 80°C see also 4.4.5.1
T_0 = 20°C
$\alpha_c = 24.10^{-6}$ /K for aluminium

$= 12.10^{-6}$ /K for steel
$\alpha_v = 9.10^{-6}$ /K for glass

A2.4.3 Bearing capacity under permanent shear loading

The glazing self-weight is considered to supported along the glazing height h_v.

$$h_c \geq \frac{P}{2.\Gamma_{\infty} \cdot h_v}$$

h_v = a or b

It is always necessary to verify that : $h_c \geq | a\,W / 2\,\sigma_{des} |$

Given the present stage of knowledge, it is advisable to respect the following relationship:

$$e \leq h_c \leq 3e$$

ANNEX 3 - Reference documents

UEAtc [1]**: Guideline "Technical Guide for the Approval of Structural Sealant Glazing Systems"**
UEAtc [2]: **Guideline "Directive for the Assessment of Windows"**
UEAtc [3]: **Directive "Façades légères"**
ISO 7111 Thermogravimetry of Polymers
ISO 1183 Methods of determining the density and relative density of non-cellular plastics.
ISO 10563 Sealants for joints - Determination of change in mass and volume
EN 27389 / **ISO 7389** Determination of elastic recovery
EN 28339 / **ISO 8339** Determination of tensile properties
ISO 9227 Corrosion tests in artificial atmospheres - Salt spray tests
ISO 3231 Testing in a saturated atmosphere in the presence of sulphur dioxide
ISO 4660 Standard colour scale
ISO 868 Plastics and Ebonite - determination of indentation, hardness by means of a durameter (Shore Hardness)
EN ISO 527 - Plastics determination of the tensile properties
EN 717-1 Acoustics - Rating of sound insulation in buildings and of building element - Part 3 : Airborne sound insulation of facade element and facade.
EN-ISO 140-3 Acoustics - Measurement of sound insulation in buildings and building element - Part 3 : Laboratory measurement of air borne sound insulation of building element.
ISO 2360 Non-conductive coatings on non magnetic basis metals - Measurements of coating thickness - Eddy current method
ISO 2128 Anodizing of aluminium and its alloys - Determination of thickness of anodic oxide coatings - Non-destructive measurement by split-beam microscope.
ISO 1463 Metallic and oxide coatings - Measurement of coating thickness - Microscopical method
ISO 2106 Anodizing of aluminium and its alloys - Determination of mass per unit area (surface density) of anodic oxide coatings - Gravimetric method
ISO 2143 Anodizing of aluminium and its alloys - Appréciation de la perte du pouvoir absorbant des couches d'oxydes anodiques après colmatage - Essai à la goutte de colorant avec action accide préalable
ISO 3210 Anodizing of aluminium and its alloys - Assessment of quality of sealed anodic oxide coatings by measurement of the loss of mass after immersion in phosphoric - chromic acid solution
ISO 2931 Anodizing of aluminium and its alloys - Assessment of quality of sealed anodic oxide coatings by measurement of the admittance or impedance
ISO 3207 Statistical interpretation of data - Determination of a statistical tolerance interval
Research on the mechanical behaviour of the silicone sealant BBRI Belgium and FMPA Stuttgart Germany
ISO 834 Fire resistance tests - Elements of building construction
Specification for the quality sign for anodic oxidation coatings on wrought aluminium for architectural purposes - QUALANOD / EURAS - EWAA / European Aluminium Association Anodisers
prEN 572 Glass in Building - Basic Products (03.94)
prEN 1863 Glass in building - Heat strengthened glass (04.97)
prEN 12337 Glass in building - Chemically strengthened glass (04.97)
prEN 1096 Glass in building - Coated glass (04.97)
prEN 1279 Glass in building - Insulating glass unit (IGU) (08.96)
prEN 12150 Glass in building - Thermally toughened safety glass (04.97)
prEN ISO 12543 Laminated and laminated safety glass (07.96)
prEN 410 Determination of light transmittance, solar and direct transmittance, total energy transmittance and ultraviolet transmittance, and related glazing characteristics. (12.97)
prEN 673 Calculation rules for determining the steady "U" value (thermal transmittance) of glazing. (06.97)
prEN 674 Measuring procedures for the determination of thermal transmittance (U value) of multiple glazing (guarded hot plate method) (06.97)
EN 10088 - 1 Stainless steels - part 1 : List of stainless steels
prEN 1363 - 2 Fire resistance test of non-loadbearing elements in building - part 2 - External walls - (06.94)
prEN 12152 Curtain walling - Air permeability - Performance requirements and classification (02.97)
prEN 12153 Curtain walling - Air permeability - Testmethod (02.97)
prEN 12154 Curtain walling - Watertighness - Performance requirements and classification (02.97)
prEN 12155 Curtain walling - Watertighness - Testmethod (02.97)
prEN 12412 Windows and doors - Thermal transmittance - calibrated and guarded hot box method (05.96)
prEN 12365 Gasket and weatheringstripping for doors, windows, shutters and curtain walling (04.96)
prEN 10077-Part 2 Windows, doors and shutters - Calculation of thermal transmittance - Part 2: Numerical method for frames (1997)
ISO 11600 Building Construction - Sealants - Classification and requirements
EN 573-3 Aluminium and aluminium alloys - Chemical composition and form of wrought product - Part 3: Chemical composition
ISO DIS 11431 (1991) Building Construction – Sealant – Determination of adhesion / cohesion properties after exposure to artificial light through the glass.