INFORMATION SCRIPT

Wet-Applied Sealants – for Installing Windows and Doors in New Constructions and Refurbishing Old Buildings

1st Edition, March 2018

DEUTSCHE BAUCHEMIE

Imprint

1st Edition, March 2018
Deadline: March 2018

248-IS-E-2018

Deutsche Bauchemie e. V.
Mainzer Landstraße 55
60329 Frankfurt am Main
Phone +49 69 2556 - 1318
Fax +49 69 2556 - 1319
www.deutsche-bauchemie.com

Design
NETmark5 GmbH, Landsberg am Lech
www.netmark5.de

Print
Frotscher, Darmstadt
www.frotscher-druck.de

Source of photographs
Member companies of Deutschen Bauchemie e. V.
AV16473_Passiv House_©DOW EUROPE GmbH
AV16893_The Pinnacle, Basingstoke_©DOW EUROPE GmbH
AV16981_Underhill House_©DOW EUROPE GmbH
AV17416_University of Birmingham Metallurgy and Materials Building_ ©DOW EUROPE GmbH
AV19264_windows_©DOW EUROPE GmbH
AV19782_Modern office building_©DOW EUROPE GmbH
AV19789_Modern office building_©DOW EUROPE GmbH
AV22145_Riverlight Residential Building London UK_©Dow Corning
Soudal N.V.
Sika Deutschland GmbH (cover)

ISBN 978-3-944138-52-7 (pdf version)

Responsible Care

Deutsche Bauchemie e. V. supports the world-wide Responsible Care Initiative

TABLE OF CONTENTS

1 INTRODUCTION

The installation of windows and exterior doors really is a science in its own right today. To improve the energy efficiency of buildings, a number of standards and regulations have been issued that place high requirements not only on the tightness of the external envelope but also thermal and acoustic insulation as well as optimal weather protection.

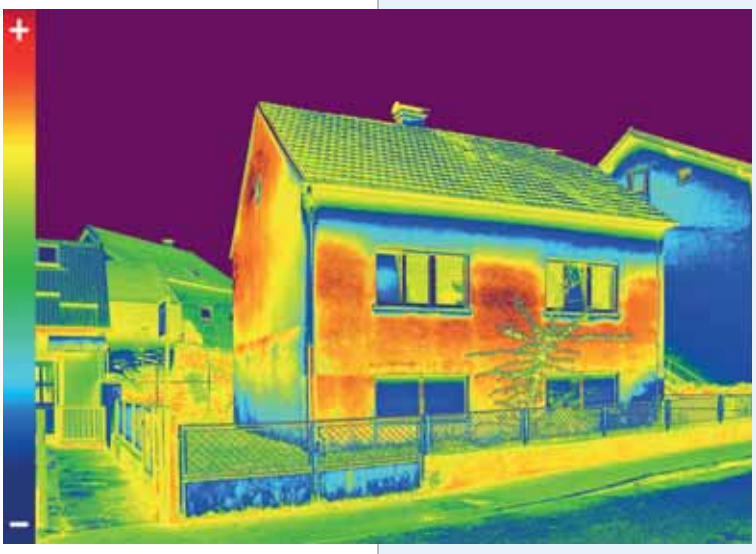
The [German] Energy Saving Ordinance in particular stipulates in this conjunction that "the heat transmitting, enclosing surface, including joints, are to be sealed so that they are permanently airtight in accordance with recognised rules of technology" (EnEV, § 6 – clause (1), Tightness, Minimum Air Exchange).

Heat bridges are created when connection joints to windows and exterior doors are improperly executed which not only lead to a high loss of energy but also damage due to mould and moisture. Careful selection of materials and professional execution by qualified workers are a guarantee for tight building envelopes.

In the market place, safety is offered by complete systems for optimal sealing of connection joints between the structure and frame construction. These systems, produced by different manufacturers, should especially meet the requirements of EnEV, DIN 4108-7 and the RAL Installation Guideline to improve energy efficiency when constructing new buildings and for refurbishment projects.

In principal, the following options are available today for sealing connection joints to windows and exterior doors:

- Joint sealants
- Pre-compressed foam tapes
- Elastomer joint water stops
- Sealing strips and sealing profiles as well as
- Sprayable and brushable coatings (liquid membranes)



Decisive for permanent, professional and economical execution of connection joints in buildings is the interaction of all participants involved in the works and the use of tested and certified materials. By this means, errors can be avoided when installing windows and doors in new buildings and when refurbishing old and thus high quality results achieved.

The goal of the Information Script is to give planners and executing firms recommendations and guidance for sealing with wet-applied sealants.

2 SEALANT SELECTION

Basic Requirements

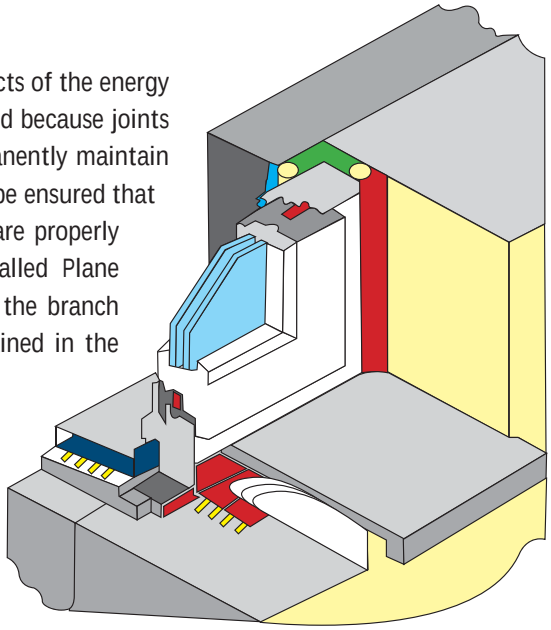
Due to the different requirements on sealants as well as the complexity of “window and door” works and the connection joints involved, it should be examined first which product properties a suitable joint sealant should have.

Especially important properties are:

- Movement capability
- Adhesive properties
- Weather and UV resistance
- Compatibility with paints
- Compatibility with adjacent building materials (e.g. natural stone)
- Water vapour diffusion resistance (physical requirement “tighter on the inside than the outside”

Plane Model

To make sure that the positive effects of the energy saving measures are not jeopardised because joints are not tight and the works permanently maintain their capacity to function, it must be ensured that connection joints in the building are properly sealed. In this context, the so-called Plane Model has become established in the branch (see diagram) which will be explained in the following.



blue – weather protection (outdoors)
red – air tightness plane
(separation of room and outdoor climate)
green – functional area
(i.e. insulation, load transmission, acoustic)
yellow– backing rod

Illustration 1: Plane Model

This model distinguishes between three planes and describes the tasks of the respective planes for planning and installing windows and house doors in new buildings and when refurbishing old buildings. Accordingly, the following functional area must be properly sealed.

a. Weather protection (blue)
b. Functional area (green)
c. Air tightness plane (red)

Weather Protection

The weather protection plane is the exterior seal of the building element and must permanently protect against driving rain and wind and be resistant to weather. When outdoor temperatures are low, the exterior seal also has the task of allowing water vapour to diffuse towards the outside. The reason for this is that in winter the warm air in heated rooms contains more moisture than the cold, exterior air. This results in a vapour pressure gradient and moisture tries to diffuse from the inside to the outside. These diffusion processes also take place in the connection joints and a sufficiently water vapour diffusion-open sealant prevents condensation from collecting in the joint which could lead to subsequent damage.

Functional Area

The functional plane is the intermediate seal which lies in the functional area between the window frame and the wall. It must be completely filled with sound and thermal insulating material. In general, this means that the functional area must “remain dry” and be separated from the room climate.

Air Tightness Plane

The air tightness plane designates the layer that separates room climate from the outdoor climate. This internal seal must be airtight and vapour diffusion tighter than the other planes (“tighter inside than outside”). This is to ensure that no moisture from the room air enters the joint, thus preventing the formation of condensation in the connection joint.

As a general principle, the requirement of legislators to execute the envelope of the building airtight is to be observed. Air tightness not only saves energy but especially prevents warm-damp air from the room side from entering the construction and condensing on the cooler materials there. In this respect, each of these areas must be professionally executed to prevent heat loss, the growth of mould and a loss of load-bearing capacity.

Recommendations for Sealants

Along with the above mentioned product requirements, it is also important when selecting a suitable product to distinguish between sealing a joint towards the outside and the inside.

Exterior (Weather Protection)

On the exterior, connection joints must be sealed wind-tight, driving rain tight and weather resistant. In the case of unventilated constructions, it is essential to seal according to the principle “tighter inside than outside”.

Due to their excellent weather resistance and durability, neutral silicone sealants are particularly suitable for exterior joints. SMP sealants (Silane Modified Polymers or hybrid polymers) and PU sealants can also be used, particularly when areas adjacent to the joint are to be coated (attention should be paid to coating compatibility).

Interior (Air Tightness Plane)

On the interior, the airtight seal that is executed must have a higher water vapour diffusion resistance than the seal on the exterior. In most cases, acrylic sealants are suitable (water vapour diffusion resistance as a rule: acrylic > SMP/PU > silicone) with a movement capability of ≥ 12.5 %. This especially applies when the interior is to be finished with wallpaper or painted. Acrylic sealants do not normally adhere to tiled or glazed substrates – so if the connection joint borders a tiled substrate (as often the case with, e.g. bathroom windows), a silicone or SMP sealant should be used instead.

In regard to selecting a sealant, the table below gives a simplified overview of today's conventional sealant technologies and their suitability for sealing windows and exterior doors. The basic suitability of products used in a sealing system should always be checked or clarified separately in advance with the recommendations given by the manufacturer.

(Table 1: General suitability and properties of wet-applied joint sealants for sealing connection joints at windows and exterior doors)

Sealing technology	Exterior joint	Interior joint	Wood (lacquer/stain)	PVC	Metal (coated)	Coatability	Compatibility with coatings	Compatibility with natural stone	Early rain resistance	Resistance to weather/UV	Water vapour diffusion resistance	Comments
Silicone (acid-curing)	-	-	-	-	-							Poor or no adhesion to cementitious substrates, thus not suitable as a rule
Silicone (neutral-curing)	+	+	+	+	+	no	yes	(+)	yes	very good	low	
Acrylic (water based)	(+)	+	+	+	-	(+)	yes	-	(yes)	good	high	As a rule no adhesion to tiles/ glazed substrates; frost-sensitive while drying
Hybrid polymer/ silane modified polymer (SMP)	+	+	+	+	+	(+)	yes	(*)	yes	good	mode-rate	
Polyurethane (PU)	+	-	+	+	+	(+)	yes	(+)	yes	mode-rate to good	mode-rate	As a rule not suitable for damp substrates

– = As a rule not recommended/only suitable in exceptional cases
\+ = As a rule suitable
( ) = Only special qualities

3 STANDARDS/REGULATIONS

1. Connection Joints

When using joint sealants, the following standards and regulations for sealing connection joints between window frames (or exterior door frames) and their adjacent building materials are particularly relevant:

a) EN 15651-1: Sealants for facade elements

This European standard includes various material tests and stipulates (among other things) the requirements on joint sealants for sealing joints to window and door frames in exterior walls, including joints on the exterior as well as joints on the room side.

Minimum requirements are placed on joint sealants which, depending on purpose, are subdivided:

- Use in exterior and interior areas (product type F-EXT-INT)
- Use in exterior and interior areas, suitable for use in cold climate zones (product type F-EXT-INT-CC)
- Use exclusively in interior areas (product type F-INT)

In the European Economic Area, these minimum requirements for the intended purpose must be fulfilled and the sealants used must have the respective CE mark.

In addition, EN 15651-1 also allows a classification of joint sealants. Joint sealants are divided into the following classes:

- Class 25LM, 25HM, 20LM, 20HM 12.5E, 12.5P and 7.5P
- Class 25LM-CC, 25HM-CC, 20LM-CC, 20HM-CC and 12.5E-CC
- Class “only suitable for use in interior areas”

Meaning of the codes:

Number	=	movement capability of the sealant in %
LM	=	low modulus of elasticity
HM	=	high modulus of elasticity
E	=	elastic
P	=	plastic
CC	=	suitable for cold climate zones

b) ISO 11600: Jointing Products - Classification and Requirements for Sealants

This international standard includes various material tests and stipulates (among other things) general requirements on joint sealants used in construction joints which include connection joints to window and door frames in exterior walls.

In the case of sealants for construction joints (type F), ISO 11600 distinguishes between the following classes:

- Class 25LM, 25HM, 20LM, 20HM, 12.5E, 12.5P and 7.5P

The meaning of the codes is the same as that given above for EN 15651-1. The tests to be executed for classification are identical to the respective classes of EN 15651-1.

c) Guideline for Installation of Windows and External Pedestrian Doors (RAL Quality Assurance Association)

The standards summarized above, EN 15651-1 and ISO 11600, serve to determine performance characteristics and the classification of sealants. This guideline, on the other hand, not only gives details on installation but also recommendations on how, for example, to dimension joint widths and depths when using joint sealants and establishes the interrelation between:

- Frame dimensions and frame material
- Dimensioning joints (width, depth)
- Movement capability of joint sealants (can be determined through EN 15651-1 or ISO 11600)

Further details on this are found in section 4.

2. Glazing Joints

When using joint sealants for glazing (sealing between the pane of glass and the window frame (or exterior door fame)), the following standards are especially relevant:

a) EN 15651-2: Sealants for Glazing

This European standard includes various material tests and stipulates (among other things) the requirements on joint sealants for sealing joints between glass and window frames or exterior door frames.

Minimum requirements are placed on joint sealants which, depending on purpose, are subdivided into the following types:

- For sealing glazing (product type G)
- For sealing glazing (suitable for use in cold climate zones) (product type G-CC)

In the European Economic Area, these minimum requirements for the intended purpose must be strictly fulfilled and the sealants used must have the respective CE mark.

In addition, EN 15651-2 also allows a classification of joint sealants. Joint sealants are divided into the following classes:

- Class 25LM, 25HM, 20LM, 20HM
- Class 25LM-CC, 25HM, 20LM-CC and 20HM-CC

The meaning of the codes is the same as those given at the beginning of this chapter for EN 15651-1.

b) ISO 11600: Jointing Products – Classification and Requirements for Sealants
This international standard includes various material tests and stipulates (among other things) general requirements on joint sealants used for glazing joints.

In the case of joint sealants for glazing joints (type G), ISO 11600 distinguishes between the following classes:

- Class 25LM, 25HM, 20LM and 20HM

The meaning of the codes is the same as those given at the beginning of this chapter for EN 15651-1.

c) DIN 18545 – Sealing of Glazing with Sealants
The standards summarized above, EN 15651-2 and ISO 11600, serve to determine the performance characteristics and the classification of sealants used for glazing joints. DIN 18545, on the other hand, not only contains details on constructive requirements but also requirements in regard to the necessary joint widths and depths and establishes the interrelation between:

- Movement capability of elastic glazing sealants (can be determined through EN 15651-2)
- Dimensioning joints (width, depth)
- Frame material (metal / plastic)
- Frame colour (light / dark)
- Size of the glazing unit
- Glazing system (sealant-free rebate, with window glazing bars, load group)

4 DIMENSIONING OF JOINTS

Joints between, for example a window element and a wall, are classified as movement joints, i.e. regular change in the dimensions of the joint is to be anticipated. The sealants used must be capable of compensating these movements in the connection joint.

Reasons for movements in the joint are, as a rule, environmental influences (temperature, moisture, wind, vibrations, etc.). Frames made of metal and plastic change in length through changes in temperature while frames made of wood change in length mainly due to the absorption of moisture (e.g. through fluctuating humidity). Along with changes in length, additional deformation may occur when strongly differing indoor and outdoor climate act simultaneously on the window or exterior door.

In addition, there may also be changes in the structure (e.g. ceiling deflection) which can also have an effect on the dimensions and geometry of joints.

If the sealants used are to be able to compensate for movements in joints, the dimensions of the joints must be properly designed – otherwise the load on the sealant may be too high, causing the sealant to fail.

The necessary joint dimensions can be determined by calculation; however, it is much easier to use tables that give the necessary widths and depths of sealants in connection joints.

Along with the properties of the frame material, the necessary joint width also depends on the movement capability of the sealant. In the case of connection joints for windows and exterior doors, the use of elastic sealants with a movement capability between 12.5 % and 25 % is recommended.

Tables 2 and 3 present the recommended joint widths for different installation situations. The dimensions of joint widths on the exterior are designed for a sealant with a movement capability of 25 %. Because loads are lighter on the interior, sealants with less movement capability can be used here.

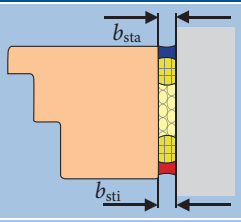
	Minimum joint width for installation with a butt reveal in mm							
	 b_{Sti} *Joint width for installation with a butt reveal, interior* b_{Sta} *Joint width for installation with a butt reveal, exterior*							
	Exterior: Sealant with a movement capability of 25 % Interior: Sealant with a movement capability of 20 % or 25 %				Exterior: Sealant with a movement capability of 25 % Interior: Sealant with a movement capability of 12,5 %			
	Element width/height in m							
Frame material	up to 1.5	up to 2.5	up to 3.5	up to 4.5	up to 1.5	up to 2.5	up to 3.5	up to 4.5
Rigid PVC (white)	10	15	20	25	12	18	24	30
Rigid PVC and PMMA (dark, extruded in colour)	15	20	25	30	18	24	30	36
Rigid PUR – integral foam	10	10	15	20	12	12	18	24
Aluminium composite profiles with thermal barrier, light-coloured	10	10	15	20	12	12	18	24
Aluminium composite profiles with thermal barrier, dark-coloured	10	15	20	25	12	18	24	30
Wood window profiles	10	10	10	10	12	12	12	12

Table 2: Recommended joint widths for planning connection joints using wet-applied sealants for a butt reveal

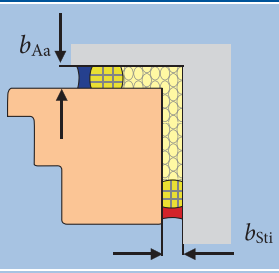
	Minimum joint width for installation with inner rebate in mm					
	 b_{Sti} *Joint width for butt reveal, interior* b_{Aa} *Joint width for inner rebate, exterior*					
	Exterior: Sealant with a movement capability of 25 % Interior: Sealant with a movement capability of 20 % or 25 %			Exterior: Sealant with a movement capability of 25 % Interior: Sealant with a movement capability of 12,5 %		
	Element width/height in m					
Frame material	up to 2.5	up to 3.5	up to 4.5	up to 2.5	up to 3.5	up to 4.5
Rigid PVC (white)	10	10		15	12	12
Rigid PVC and PMMA (dark, extruded in colour)	10	15	20	12	18	24
Rigid PUR – integral foam	10	10	15	12	12	18
Aluminium composite profiles with thermal barrier, light-coloured	10	10	15	12	12	18
Aluminium composite profiles with thermal barrier, dark-coloured	10	10	15	12	12	18
Wood window profiles	10	10	10	12	12	12

Table 3: Recommended joint widths for planning connection joints using wet-applied sealants in case of an inner rebate

The necessary joint depth (thickness of the sealant) is derived from the joint width. For joint widths ≥ 10 mm, the rule of thumb is:

Joint depth ≈ half the joint width

Always remember that joint depth should not be less than 6 mm and not more than 18 mm. Deviating dimensions are possible after consultation with the manufacturer of the sealant.

Joint width b in mm	Joint depth t in mm
10	6
12	6
15	8
18	9
20	10
24	12
25	13
30	15
36	18

Table 4: Joint depths for different joint widths

In Table 4, arithmetical values are given for joint depths and different joint widths.

Joint widths and depths for connection joints can also be determined by calculation. To calculate these, first the anticipated changes in the dimensions of the connection joints are calculated, then joint width, depending on the movement capability of the sealant, and finally joint depth depending on joint width.

Example: Calculation of the anticipated changes in dimensions of a connection joint and calculation of the required joint width and depth.

a) Thermally induced changes in the length of frame profiles that cause changes in the dimensions of connection joints can be calculated, using the following formula:

$$\Delta l = l_0 \times \varepsilon$$

Δl = change in dimension caused by temperature induced change in length in the connection joint on each side in mm
l_0 = initial length of the frame in m
ε = temperature induced change in length value in mm/m

For typical central European temperature differences, the values for change in length per joint are found in the following table:

Frame material	ε in mm/m
Rigid PVC (white)	1,6
Rigid PVC (coloured) and PMMA (coextruded in colour)	2,4
Rigid PUR – integral foam	1,0
Thermally insulated aluminium composite profile (light-coloured)	1,2
Thermally insulated aluminium composite profile (dark-coloured)	1,3
Wood window profile*	no information

Table: Joint depths for different joint widths [Source: RAL Guideline]

** Wooden working materials are subject to a continuous swelling and shrinkage process. The type of wood and the cross-sectional dimensions influence the degree of change in length. A change in length of at least 1 mm can be assumed.*

In the case of a 1.50 m wide, white PVC window, the following change in dimension of the connection joint is calculated as follows:

$$\Delta l = l_0 \times \varepsilon = 1{,}50 \text{ m} \times 1{,}6 \text{ mm/m} = \mathbf{2{,}4 \text{ mm}}$$

b) The joint width required for the connection joint can be calculated using the following formula:

$$\mathbf{b = \Delta l \times 100\ \% / \text{movement capability}}$$

b = Joint width in mm
Δl = change in dimension caused by temperature induced change in length of the connection joint on each side in mm
Movement capability = movement capability of the sealant in %

If a sealant with 25 % movement capability is used, the following joint width will be required for this example:

$$\mathbf{b = \Delta l \times 100\ \% / \text{movement capability}} = 2{,}4 \text{ mm} \times 100\ \% / 25\ \% = 9{,}6 \text{ mm} \approx \mathbf{10 \text{ mm}}$$

A joint width of 10 mm is required. If sealants with a different movement capability are used, joint width must be calculated accordingly.

c) Not only the joint width but also the joint depth must be calculated for the sealant. The following rule of thumb is used for calculation:

$$\mathbf{t = 0{,}5 \times b}$$

t = Joint depth in mm (thickness of sealant)
b = Joint width in mm
Prerequisites: **Joint width ≥ 10 mm**
Joint depth should not be less than 6 mm
Joint depth should not be more than 18 mm

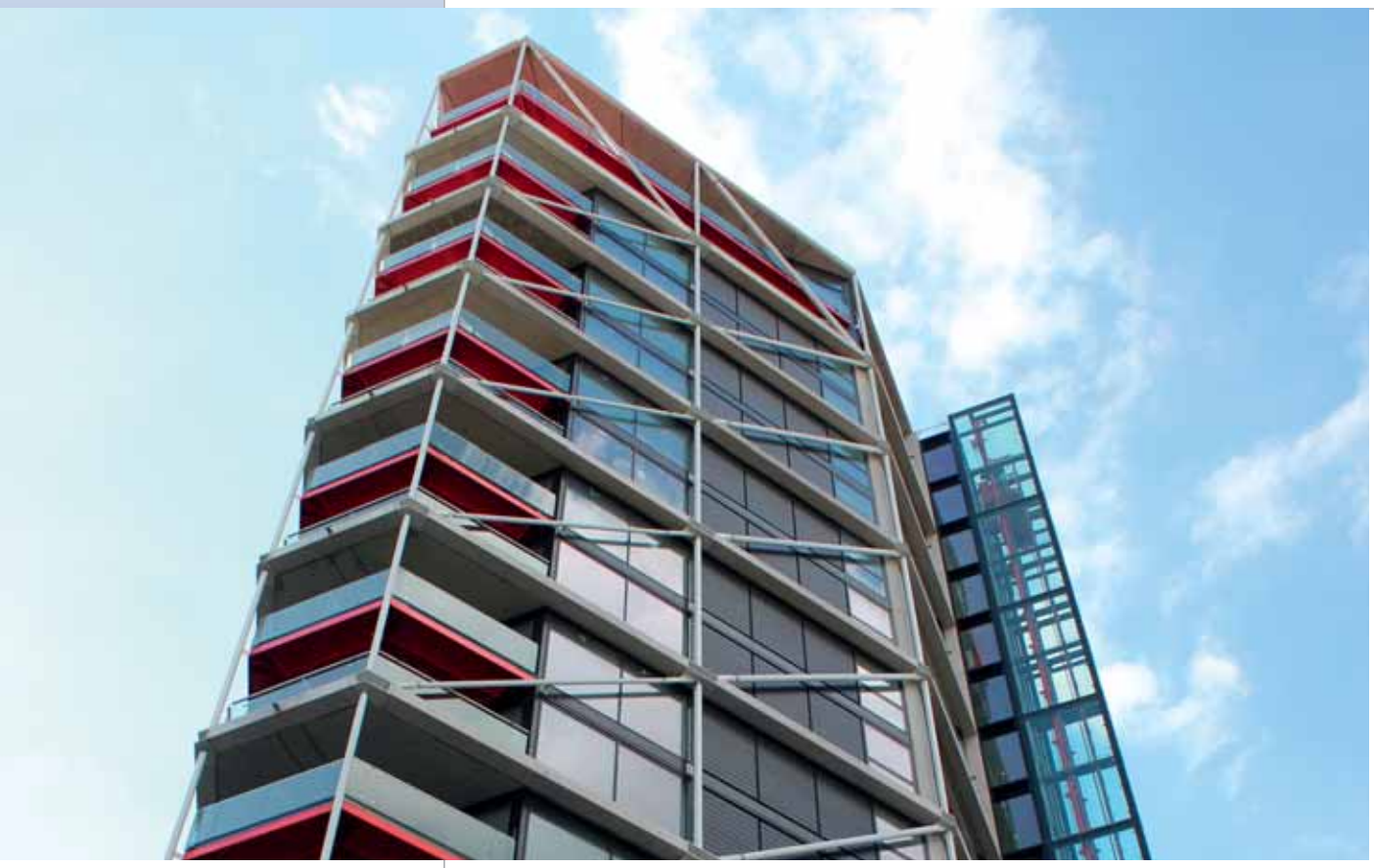
In this example, the following joint depth is calculated:

$$\mathbf{t = 0{,}5 \times b} = 0{,}5 \times 10 \text{ mm} = \mathbf{5 \text{ mm}}$$

In purely arithmetical terms, a joint depth of 5 mm is required; however, the rule is that the depth of the joint must be at least 6 mm. Thus a joint depth of 6 mm is required, i.e. the cured sealant must be 6 mm thick.

Summary of the Calculation:
If a sealant with a movement capability of 25 % is used for a 1.50 m wide, PVC window (PVC rigid, white), a connection joint with a joint width of 10 mm will be required and a joint depth of 6 mm for this sealant.

5 STRUCTURAL PREREQUISITES



Also decisive for the long-term functionality of sealed joints is load bearing capacity and cleanliness of the substrate and therefore adhesion behaviour.
A basic rule is that substrates/sides of joints must be clean, load bearing, dry and free of grease. Their strength and suitability as a substrate for adhesive materials should be examined in advance.

If strength – especially in the case of render – is of vital importance, the suitability of many substrates as a surface for adhesive materials must be critically evaluated first. There are plastics and/or coatings to which adhesive materials do not adhere well. Self-cleaning surfaces with a “lotus effect” and several types of powder coatings may be entirely unsuitable. Residue from formwork oil or impregnations (e.g. hydrophobizing agents) on the substrate may also make durable adhesion of the sealant difficult or even impossible. Appropriate preliminary testing is a necessity when dealing with unknown material combinations. The most reliable method is a pull-off adhesion test executed by the manufacturer of the sealant. This test produces reliable and reproducible results that also allow a long-term assessment.

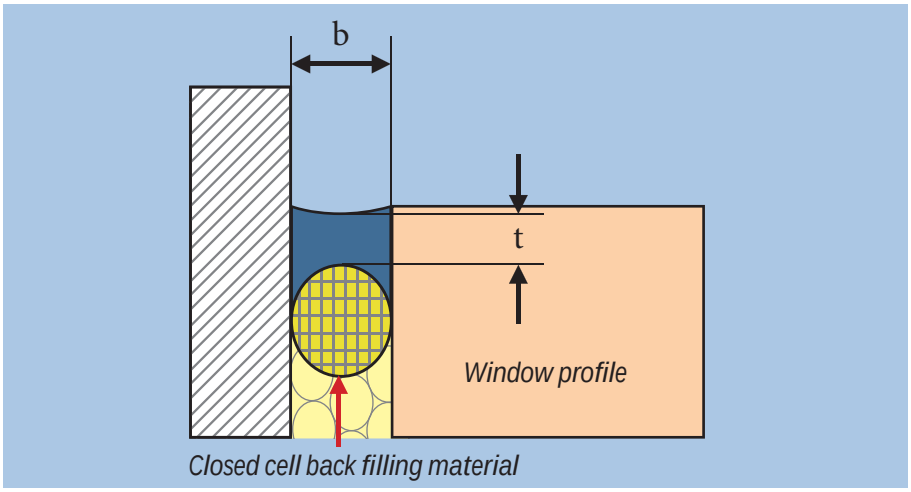
The surface of the substrate must be suitable or prepared for jointing. If the surface is too uneven, it can be levelled with, for example, a smoothing compound to produce smooth joint sides that are parallel to each other. In the case of masonry work, mortar that is missing in horizontal joints, for example, should at least be levelled with a joint smoothing compound. In refurbishment cases, it should be ensured first that no old sealing material adheres to the sides of the joints.
Depending on the substrate or frame material, pre-treatment with a primer may also be necessary – recommendations for this are found in the information provided by the manufacturer of the sealant for the specific product.

In the case of aluminium or plastic window profiles, if the groove cover profile or cover strip is missing the surface cannot be properly sealed and correct dimensions of the joints cannot be maintained. The use of groove cover profiles is essential for properly sealing window connection joints.

When sealing joints, adhesion on two sides of the joint is to be ensured by the use of a suitable back filling material (see illustrations 2 and 3). Closed cell PE backing rods are especially suitable for this purpose. Since sealants do not adhere to the back filling material, the sealant can expand or be compressed unhindered when there are movements in the joint. If the sealant additionally adhered to a further side of the joint (so-called three side adhesion), additional forces would occur when there are movements in the joint which would hinder movement of the sealant. This normally leads to failure of the seal (cohesion cracks and/or loss of adhesion). The back filling material also serves to limit the depth of the joint, forming the required width and depth ratio of the sealant in the joint.

Requirements for proper execution are to be stipulated during the planning stage.

Illustration 2: Details of a connection joint (Example 1)



t = depth of the sealant in the joint
b = width of the sealant in the joint

The ratio of depth to width should be approx. t:b ≈1:2.

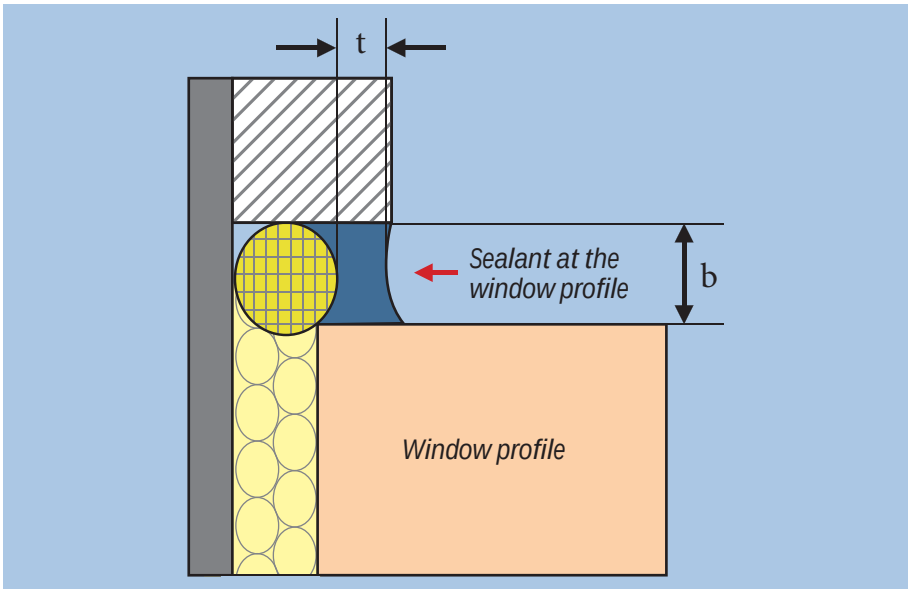


Illustration 3: Details of a connection joint (Example 2)

6 USE FOR CONNECTION AND GLAZING JOINTS

Connection Joints

When installing windows and doors, there are very comprehensive and special requirements for sealing joints. To be able to utilise the full performance capability of the sealants used, they must not only be carefully selected for the intended purpose but must also be correctly and carefully applied. The respective information provided by the manufacturer should also be taken into consideration. There are several, generally valid guidelines regarding application that should be observed to ensure that seals function properly.

Before using the sealant, always make sure that the construction materials used are compatible with each other. It cannot be ruled out that external influences or certain materials or substances in these materials may cause superficial discolouration of the sealant. On the other hand, the use of an unsuitable sealant may also discolour adjacent building elements (e.g. natural stone).

Preparation includes 3 essential working operations “clean – back fill – prime”.

1. Clean the surface to which the sealant is to adhere: These surfaces must be clean, i.e. they must be free of dust and grease. They must also be load bearing and dry. Brush off loose material on concrete and render surfaces. Clean the surfaces of the frame that will be sealed with an agent recommended by the manufacturer of the sealant.

2. Back fill: Back fill connection joints using a closed cell PE backing rod. Back filling limits joint depth and dictates the shape of the hind side of the sealant. This produces a sealant cross-section (depth: width) of ≈ 1:2 hergestellt. *(see section 5, illustrations 2 and 3 – Details of a connection joint)*

3. Prime: To achieve optimum adhesion of the sealant to the sides of the joint, an adhesion promoter or so-called primer is used. Basically, there are primers for absorbent and for non-absorbent substrates, most of which are applied with a brush. Manufacturers provide respective tables with corresponding recommendations.

Application

To achieve perfect joints, it is recommended to mask the edges of the joints with a suitable adhesive tape. Using a hand or compressed air gun, the sealant is injected from the cartridge or tubular bag evenly and bubble-free into the pre-treated joint. With the aid of a smoothing agent and suitable smoothing tool, the surface is smoothed before the skin formation time has expired. Immediately afterwards, the adhesive tape is removed.

Glazing Joints

Glazing joints between the pane of glass and the frame material differ from other connection joints simply because of their different surface materials and properties. Targeted selection of material, compatibility of the materials used and observance of several fundamental principles for application ensure that a durable result will be achieved. Information given by the manufacturer for the respective products should also be observed.

Preparation also includes 3 essential working operations “clean – back fill – prime”.

1. Clean the surface to which the sealant is to adhere: These surfaces must be clean, i.e. free of dust and grease and air dry. Use a cleaning agent recommended by the manufacturer of the sealant for cleaning.

2. Back fill: In the case of glazing, the joint substrate is as a rule rigid and, in this case, differently formed back filling materials can be used to achieve the correct joint dimensions. Elastic cell or PE tapes have proved to be suitable for this purpose. Oil, tar or bitumen based back filling materials as well as materials on a natural rubber or chloroprene base are not suitable. The compatibility of other materials, e.g. EPDM, with the sealant, should be tested first.

3. Prime: Good adhesion is achieved on many surfaces and materials without an additional adhesion promoter (primer). Manufacturers provide respective tables with corresponding recommendations. Primer that has inadvertently been applied beyond the edges of joints should be cleaned immediately with a suitable cleaning agent to achieve perfect results.

Application

To achieve perfect joints, it is recommended to mask the edges of the joints with a suitable adhesive tape. Using a hand or compressed air gun, the sealant is injected from the cartridge or tubular bag evenly and bubble-free into the pre-treated joint. The surface should be smoothed before the skin formation time has expired, using a suitable smoothing tool. The use of a smoothing agent should be reduced to a minimum to prevent sealant that has not yet cross-linked from being washed off. The adhesive tape should be immediately removed afterwards. Any smoothing agent on glass/ frame surfaces should be washed off with clean water right away.

7 CLEANING AND INSPECTION OF CONNECTION JOINTS

Elastic seals made of wet-applied sealants used in connection joints are basically deemed low-maintenance. The central condition for this is that the details of the connections in the building are planned, professionally executed according to the generally recognised state-of-the-art and that the properties of the materials have been coordinated to the anticipated effects.

During the course of regular maintenance cleaning of windows and doors (once or twice a year), it is recommended to carry out a visual inspection (monitoring) and, if necessary, to repair local damage to seals as a measure to safeguard the value of the building. This ensures that if seals are damaged, the damage is found in due time to prevent consequential damage.

The durability of joint seals depends on a number of influencing factors:

- Acids and acidic cleaning agents (e. g. acetic acid, etc.)
- Other mediums with a strongly corrosive effect (e. g. disinfection agents that contain chlorine, etc.)
- Mechanical cleaning aids (brushes, scrapers, etc.)
- Constant effect of water (e. g. standing water or condensation)
- Vandalism
- Overloading through unanticipated high deformation
- Shortcomings in planning (incorrect joint dimensions, incorrect selection of sealant)
- Poor workmanship, no or inappropriate preparation (clean, back fill, prime)
- Incompatibility of adjacent building materials and sealants (e.g. soiled edge zones, discolouration, softening or loss of adhesion)

When cleaning connection joints to windows and doors, only cleaning agents with pH-neutral surface active agents (soaps) in a maximum 1-percent solution are recommended. Normal soiling can be removed with these agents without causing harm to the sealant and adjacent surfaces.
When using cleaning agents, it is not advised to use a high pressure cleaner, hard brush or other tools that are abrasive. Instead, use soft rags or a sponge for cleaning along with lots of water.

8 REFURBISHMENT

Experience and a good eye are required to be able to asses whether the sealant used has failed or an unsuitable material has been used. A defective joint seal made of wet-applied materials can be damaged in a number of ways of which there are 3 main categories:

- Detachment from the side of the joint (so-called adhesion or adherence failure)
- Tear of the sealant (also called cohesion failure), as well as
- Defects in along joint edges, e.g. discolouration in the edge zone, infiltration of plasticisers or soiling.

If the joint is damaged, e.g. infested with mould, the joint must be renewed, ideally using the original sealant. First the joint material should be completely removed from the joint, leaving no residue. Once removed, it must be clarified what type of sealant was originally used. In case of doubt, laboratory analysis by the manufacturer of the sealant is recommended. To understand why this test is so important, here an example: silicone sealants can be removed easily but any residue that adheres to the sides of the joint may inhibit the use of another type of sealant because it does not adhere to silicone.

When renewing joints, the following approach is recommended:

1. The old and damaged sealant must be cut out with a sharp knife, cutting as close as possible to the sides of the joint. The back filling material that was used must also be removed.

2. To achieve a surface that is as clean as possible on the sides of the joint, the sides can be additionally worked over with a grinder.

3. Afterwards, a closed cell back filling rod is inserted into the cleaned joint.

4. To prepare the sides of the joint, an adhesion promoter coordinated to the manufacturer's sealant system is applied.

5. Following this step, the sealant is applied, using adhesive tape on edges as an aid when necessary.

6. The surface of the sealant is then smoothed with a smoothing agent recommended by the manufacturer.

9 INSTALLATION/REPLACEMENT OF GLAZING

This chapter deals with glazing of windows and doors, using wet-applied sealants at the construction site (wet glazing), similar to sealants used for wooden frame constructions and special constructions.

This may be necessary when damaged sealants must be renewed, panes of glass must be replaced or when special constructions (e.g. show windows, glass corners) are to be glazed.

Damaged or broken glazing in wood windows and doors can be replaced on site. When doing so, the original installation situation should be noted (glass dimensions, rebate, glazing blocks, etc.) and remain unchanged when the glazing is replaced. Observance of relevant glazing guidelines (e. g. ift Guideline “Verglasung von Holzfenstern ohne Vorlegeband” [Glazing Wood Windows without Glazing Tape]) in the respective current version is recommended.

Approach:

1. First the existing glazing sealant is separated directly along the glass surface with a sharp blade on the inside and outside (observe job safety measures, e.g. protective gloves and glasses).

2. Then remove the glazing beads and safely lift the pane of glass out towards the inside (using suction holders if possible).

3. Before installing the new glazing, check the sealant remaining on the frame and glazing beads for adhesion. If the sealant adheres well to the substrate, the sealant does not need to be completely removed.

4. It is recommended to cut the old sealant back until only a thin layer remains to avoid damaging the substrate (as a rule a coating). The cut surface should not be contaminated with dirt or grease (e.g. a finger print).

5. The sealant should be selected according to the specifications given by the window or glazing manufacturer. When self-cleaning glass with a photo-catalytic, hydrophilic surface is installed, silicone sealants should not come in contact with the glass surface. Only SMP sealants are approved and listed by the glass industry for sealing glazing joints when self-cleaning glazing is used.

6. After the new, well-cleaned pane of glass (glazing blocks, cover strips) has been installed, the joints remaining on the inside and outside between the glass and frame are sealed properly as described in chapter 6, section B. Glazing Joints, using a fresh silicone sealant. The fresh sealant will homogeneously adhere to the existing remains of the old silicone sealant.

10 BIBLIOGRAPHY

[1] Beitrag in GFF 04/2012 „Die richtige Mischung macht das dichte Fenster“

[2] Praxishandbuch Dichtstoffe, Eberhard Baust, Wolfram Fuchs, IVD, 5. Auflage, 2004, Düsseldorf

[3] DIN 4108 Thermal protection and energy economy in buildings – Part 2 and 3

[4] Guideline for installation of windows and external pedestrian doors for new buildings and refurbishment, RAL Quality Assurance Association Windows, Facades and Doors e.V., ift Rosenheim – Institut für Fenstertechnik e.V., Edition: December 2016, ISBN: 978-3-86791-402-4

[5] German Energy Saving Ordinance – EnEV (Regulation on energy-saving thermal insulation and energy-saving installations in buildings)

[6] EN 15651-1: Sealants for non-structural use in joints in buildings and pedestrian walkways – Part 1: Sealants for facade elements

[7] EN 15651-2: Sealants for non-structural use in joints in buildings and pedestrian walkways – Part 2: Sealants for glazing

[8] ISO 11600: Jointing products – Classification and requirements for sealants

[9] DIN 18545 – Sealing of glazing with sealants – Requirements for rebates and glazing systems

[10] ift Richtlinie VE-13/2 „Verglasung von Holzfenstern ohne Vorlegeband“, Institut für Fenstertechnik Rosenheim, 2015

[11] Pröbster, M. "Baudichtstoffe – Erfolgreich Fugen abdichten", 2016

11 EPILOGUE

This Information Script “Wet-Applied Sealants – Use for Installing Windows and Doors in New Construction and for Refurbishing Old Buildings” was prepared by Project Group 7.5 “Sealing Windows” and adopted by Expert Committee 7. This Information Script is intended as information for users of construction sealants as well as the specialised public.

Project Group 7.5 is made up of the following members:

Dr. Andreas **Bolte**
Henkel AG & Co. KGaA, Düsseldorf

Dipl.-Ing. Petra **Fischer**
Deutsche Bauchemie e. V., Frankfurt

Karsten **Ollesch**
Soudal N.V., Leverkusen

Olaf **Pretzsch**
Dow Silicones Deutschland GmbH, Wiesbaden

Tina **Schindler**
Sika Deutschland GmbH, Stuttgart

Dipl.-Ing. Mario **Sommer**
Sopro Bauchemie GmbH, Wiesbaden

Matthias **Wagner**
tremco illbruck GmbH & Co. KG, Köln

Deutsche Bauchemie e. V. would be pleased if you would share your experience regarding this Information Script and invites you to make comments which should be directed to the main office in Frankfurt.

Deutsche Bauchemie e. V.
Mainzer Landstrasse 55
60329 Frankfurt am Main
Phone +49 69 2556 - 1318
Fax +49 69 2556 - 1319
www.deutsche-bauchemie.com

DEUTSCHE BAUCHEMIE