Hilti Fire prevention

Taking up movement at firestop joints

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1. Introduction

Joints are planned structural elements of buildings of all kinds. Correctly designed joints must be able to compensate for movement between parts of the structure and movement of the structure as a whole.

These movements are the result of temperature fluctuations, wind loads, vibration or earthquakes, etc. Structures without joints would be entirely rigid and likely to suffer damage or destruction by the influences mentioned above.

In contrast to a joint, a gap is an unplanned, elongated opening where no movement is foreseen.

A firestop joint sealant has the primary task of providing a tight, lasting seal at a joint where movement takes place. Only in the event of a fire does its firestopping ability become significant. The joint sealant's firestopping properties are verified by carrying out fire exposure tests.

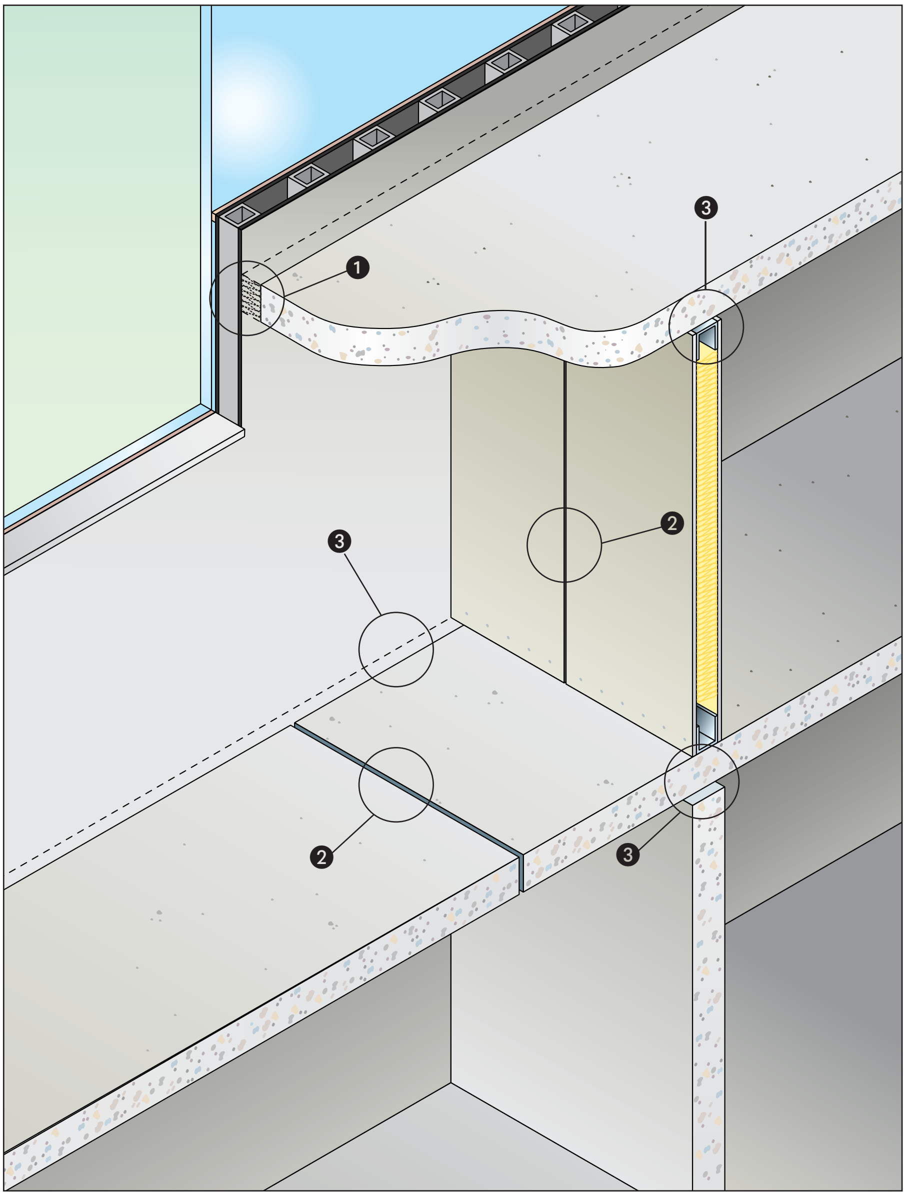
This brochure is intended to explain the basic principles of firestop joint sealing systems.

2. Basic principles

In order to compensate for the movement of a building, all systems used to seal joints must be flexible. This characteristic must be ensured by the elasticity of the sealing material itself or by the design of the sealing system used.

In addition to taking up movement, depending on the type of building in question, joint sealing systems are required to fulfill various other requirements:

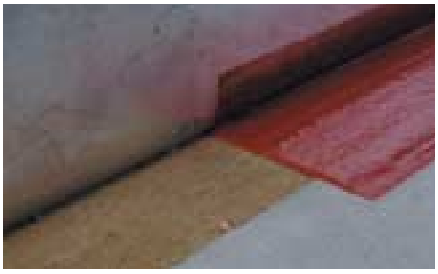
- Stop the spread of fire and smoke
- Prevent draughts and provide insulation
- Prevent penetration of water and dampness
- Sound-proofing
- Prevent penetration of gases and chemicals
- Protection from dirt and vermin



Joints in a building have the task of taking up movement between parts of the structure. The joints therefore have to be "planned" by architects and planners with regard to the maximum expected amount of movement.

The dimensions of the joints must be compatible with this maximum movement.
The upper limits for taking up movement at joints are generally assumed to be ±25% for silicone sealants and approx. ±10–15% for acrylic sealants.
Joints are a planned element of the structure and not simply a gap between building components.

A difference is drawn between the following types of joint:



❶ Joints between floors and outer walls (facades)

❷ Wall – wall or floor – floor joints

❸ Wall – ceiling or wall – floor joints

3. Joint sealing materials

In a hardened state, joint sealing materials are rubber-like elastic materials which usually have a silicone, acrylate or polyurethane (PU) basis. These materials, for the most part, have already been used in practice for a long period of time and reliable figures based on experience are thus available regarding their aging characteristics.

With all sealants, it is important that their chemical stability and elasticity remains virtually unchanged even after a long period of time. This ensures that the joint seal remains functional. A joint seal can function reliably in the event of a fire only if it remains intact.

Properties and suitability:

	Hilti CP 601S silicone	**Hilti CP606 acrylate**	**Standard acrylate**	**PU**
Elasticity as per ISO 11600	High +/–25%	Medium +/–12,5%	Low +/–10%	High +/–25%
Resistance to theat (in buildings: 30°C – 60°C): softening, chemical decomposition	++	+	+	+
Resistance to temperatures obve100°C: softening, chemical decomposition	++	O	O	-
Resistance to low temperatures: embrittlement and fracturing	++	O	O	+
Resistance to UV radiation: discoloration	++	+	+	+
Resistance to solvents: softening, shrinkage or expansion	O	+	+	-
Resistance to water-based solutions: softening, shrinkage or expansion	++	O	-	++
Water and dampness: leaching of components	++	+	+	+
Mechanical stress: embrittlement and fracturing caused by movement	++	+	+	++
Migration of components: polymers to increase flexibility, pigments	-	++	++	O
Microbial attack: decomposition of polymer chains and auxiliary agents through the action of fungus or bacteria	+	+	+	+
Shrinkage in %	0–5	20–25	30–40	8–15
Suitability for painting over	-	++	++	O

++ Very good
+ Good
O Moderate
- Poor

4. Types of joint

The following points must be considered with regard to the type of joint:
- Optimum adhesion at the joint shoulders, with use of a primer if necessary
- Correct thickness to width ratio
- Avoidance of adhesion at 3 shoulders

There are 3 main methods used for sealing joints which, in addition to other criteria, must fulfill firestop requirements:

1. Joint sealing using elastic foam profile sections or sealing strips
Advantages: Quick and easy to install

Disadvantages: The sealing material can fall out of wide gaps

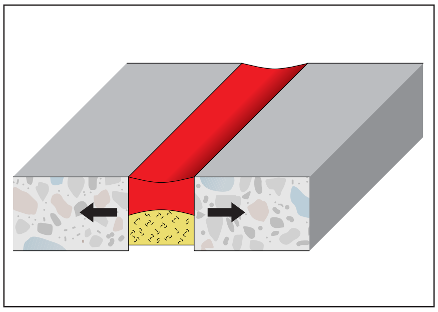
Precompression of Hilti CP 665 round firestop sealing strip: approx. 25%
Maximum amount of movement taken up: ±10%

CP 665 round firestop sealing strip

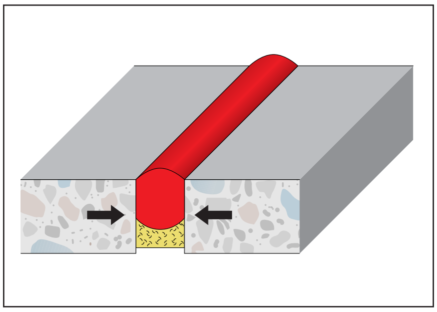
2. Joint sealing using sealants backfilled with mineral wool
This system is most frequently used for sealing firestop joints. The disadvantage of the system is its limited ability to take up movement: the sealant may be squashed under high compression or may be pulled away from the shoulders of the joint under high tension.

CP 601S firestop sealant
CP 606 firestop joint filler

Deformation



Taking up contraction



Compression

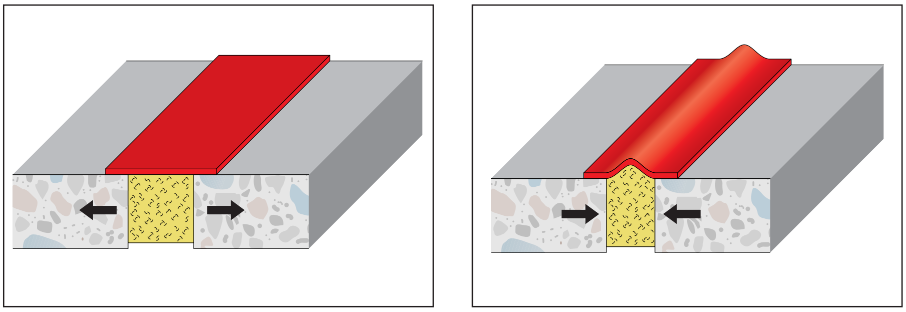
Joint dimensions
Generally speaking, the following rule of thumb applies: The firestop sealing material installed in the joint should have a thickness of half the width of the joint and be at least 6 mm, but no more than 20 mm thick. The installation instructions provided with the firestop sealing material must be observed.

CP 604 self-leveling elastic firestop sealant, CP 672 firestop joint spray

3. Liquid membrane covering mineral wool

The decisive advantage of this system compared to previous systems is its ability to take up significantly greater movement. Hilti CP 672 firestop joint spray has been tested with movement of up to ±50%. As this system is used, above all, for sealing firestop joints at facades, this ability to take up considerable movement is necessary.

A further advantage of this system is its flexibility during installation on the construction site. The system can be used to cover and seal virtually any width of joint within the scope of the applicable approval regulations.



5. Testing procedures

Characterization of joint sealants
All joint sealants are damaged to some extent by UV radiation, dampness, chemicals and temperature extremes. Standards therefore apply to how these particular influences are tested.

ISO 11600 is applicable in Germany and Europe, while the ASTM C 920 standard is applied in the USA for the characterization of sealing materials. These two standards are structured similarly and therefore lead to similar results. The foreword to the ASTM C 920 standard, in particular, points out the transferability of results.

In the following paragraphs we take a closer look at the criteria of the ISO 11600 standard.

This test procedure incorporates a whole series of tests concerning elastic behavior, tensile strength and modulus of elasticity at various temperatures as well as adhesion to various base materials after exposure to UV radiation and storage under water.

The decisive measure of the usability of a firestop sealant in terms of its ability to take up movement is its modulus of elasticity, determined in a tensile strength test carried out in accordance with ISO 8339: this must be less than 0.6 N/mm^2 at -20°C after aging. In other words, the sealant must remain elastic after aging and at low temperatures. This is important in order to ensure that the sealant does not become brittle at low temperatures, causing the sealant to tear away at the shoulders when movement occurs.

After completion of this test, the Hilti firestop sealant is ranked in the highest category “class 25LM”. In terms of joint width, this means that CP 601S is capable of taking up a movement of between +25% (tension) and –25% (compression).

The difference between “taking up movement in accordance with ISP 11600” and “elongation at break”
The values for “taking up movement in accordance with ISP 11600” and “elongation at break” are frequently confused. Almost every sealant – silicone or acrylate – easily achieves an “elongation at break” of much more than 100% in tensile strength tests. This leads many to believe that this value can also be applied to the design of joint widths.

At this point it must be made clear that the values for “elongation at break” are obtained from tensile strength tests carried out using standard test specimens. The value obtained represents the elongation at the point of breakage of the test specimen. The test specimen is thus already subject to plastic deformation at the time of breakage.

However, as a sealant must be capable of taking up movement at a joint, it is incorrect to use “elongation at break” to characterize a sealant. When a sealant is subjected to a tensile strength test of this kind, adhesion to the surface of the base material is not taken into account. Temperature and aging influences are also completely ignored.

Summary

Classification of a sealant	Product test: Elongation at break
ISO 11600 and ASTM C 920	e.g. ISO 5889, ISO 9047, ISO 8339
The test standard applies, above all, to adhesion tests on the type of surfaces on which the product is intended to be used.	The various tests apply to standard test specimens which are stamped out of a slab of material. Interaction with the base material is not tested.
Specimens are aged by various means before testing in order to ensure that adhesion to the base material is also included in the test.	The test specimens are not aged for the purpose of the test. If aging is demanded, only the slab of sealant material is aged.
Consequently, a maximum movement of ±25% can usually be taken up.	This test produces values of several hundred percent, depending on the test and the sealant tested.

Use of a primer

With firestop joint sealants, adhesion to the base material is the main criterion for faultless functioning. This is also a decisive in terms of long life expectancy.

Use of a primer to increase adhesion on base materials that are otherwise incapable of supporting a sealant is highly recommended, even when this is not mandatory. In the end, the user carries the responsibility. Only he can assess the loadbearing capacity of the base material.

When using a primer, care must be taken to ensure that it is of a type approved for use with the applicable type of sealant. In addition, the instructions for use must be observed.

6. Joint testing for firestop applications

Various fire tests for joints are in use throughout the world. All of these are based on different interpretations of how fire spreads.

Germany
Fire tests for joints are generally regulated by DIN 4102, part 2. The institute for materials, construction and fire protection (IBMB), as a part of the University of Braunschweig, Germany, has drawn up a special procedure for testing sealed joints.
This requires 4 joints to be installed in a 2-meter section of ceiling. Two of these are situated in the central part of the ceiling and the others take the form of connecting joints between the ceiling and the vertical walls. During the test, the ceiling is bent by a defined amount, representing the deformation that occurs during a fire as a result of softening of the steel reinforcement.
The joints are thus subjected to powerful tensile and shear forces which, at worst, can cause the sealant to be pulled away from the wall.

This test provides additional safety by ensuring that the joint remains sealed even when subjected to considerable stress. It is expected that this test will form part of the new EC standard for joints of this kind.

Great Britain
Here, firestop joints are subjected only to a static fire resistance test in accordance with BS 476 part 22.

USA
In the USA, the fire test is carried out in accordance with UL 2079. Before the test, the specimen is subjected to dynamic loading in accordance with ASTM E 1399. The module is subjected to 500 test cycles at an amplitude in accordance with the specifications given by the manufacturer. The subsequent fire test is then carried out on the correspondingly opened joint. The value for “width of opening” is then given as a percentage in the test report and limitation of the use of the product for firestop applications is based on this value.

7. Tested systems from Hilti

	CP 601S	CP 604	CP 606	CP 672
ISO 11600	✓		✓	
Fire test in accordance with UL 2079 after dynamic loading	✓	✓	✓	✓
Fire test in accordance with IBMB procedure	✓		✓	
Watertightness in accordance with Hilti internal test	✓	✓	✓	✓
Gas tightness in accordance with EN 1026	✓	✓	✓	✓
Sound-proofing test in accordance with ISO 140	✓	✓	✓	✓

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