

Selecting Sealants Based on Masonry Movement

The Construction Specifier

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Movement capability must be considered when selecting the proper sealant for joints in clay or concrete masonry walls. Sealant extensibility can be a key factor in determining joint width and spacing, and in preventing cracks. This capability is crucial to avoid cohesive and adhesive sealant failures, and should be selected based on a variety of masonry movements.

Causes of masonry movement

A number of factors cause masonry wall systems to move, including temperature changes, swelling from moisture absorption, and material shrinkage. Such movements can be predicted accurately during the design phase by using current building codes and the lessons learned from years of institutional research.

Clay brick and concrete masonry, like most building materials, contract and expand with changes in temperature. (Movement from temperature variation is theoretically reversible.) When these two materials are used together or with other materials within a wall system, it is important to consider potential differential thermal movements.

Often, surface temperatures far exceed the range of surrounding air or ambient temperatures due to sun exposure on building faces. Interior temperatures and heat transfer between inside and outside climates can also affect thermal movement of the wall system. Movements due to temperature changes can be computed using the thermal coefficients of expansion determined by a variety of institutional laboratory tests.

Swelling due to moisture absorption is another considerable influence on masonry movement. Clay brick masonry will expand from exposure to atmospheric moisture and water contact. This occurs slowly over a long period. Once the clay brick has expanded (and continues to do so), it will not return to its original size upon drying.

Concrete masonry, unlike clay brick, will expand with moisture gain and contract with its loss. Since concrete masonry is a Portland cement-based material, moisture loss and carbonization will cause it to shrink. The amount of drying shrinkage depends on several factors, including:

- Original moisture content of the block
- Water-cement ratio
- Type of cement
- Aggregates

- Placement of reinforcing steel
- Original mix proportions

It is critical that concrete masonry (especially moisture-controlled units) be kept from absorbing moisture during transportation, delivery, storage, and erection to minimize the potential for excessive drying shrinkage afterward. The shrinkage of clay brick masonry, on the other hand, is negligible.

The following occurrences may also cause masonry movement, in conjunction with poor design, water infiltration, and extended exposure to the elements:

- Differential or extensive foundation settlement
- Carbonization of concrete and mortars
- Crystallization of salts 1
- Freeze-thaw cycles of water
- Corrosion of embedded steel
- Building or frame deformation from lateral forces
- Insufficient or inappropriate jointing
- Differential movement between masonry and its structural support
- Creep 2
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Although these causes of movement can damage a masonry wall, water is the most common source of problems. Proper joint design with the appropriate sealant is therefore an important defense against common problems.

Jointing for movement

Cracked masonry walls allow water to infiltrate, increasing the potential for damage. Cracking bears witness to various stresses in the wall system that were insufficiently accounted for in the design.

The placement and spacing of joints in masonry walls should be influenced by the actual, analyzed tensile and shearing strengths of the wall, accounting for differential movement of the construction materials. Each building should be analyzed and designed to account for the number and spacing of openings, material selection, maximum stress concentration points, and anchorage flexibility. By accommodating all stresses with adequate wall support and flexible, properly designed joints, many causes of cracking may be eliminated.

There are four major categories or types of joints used in masonry wall systems that allow differential movement:

- Through-building expansion joints, which accommodate the stresses of structural differential movement, movement due to lateral wind forces and seismic activity, and sometimes settling.

- Wall expansion joints, which allow the movement resulting from swell, usually caused by moisture absorption.
- Wall control joints, which accommodate the rapid thermal expansion and contraction from temperature differentials within a wall.
- Construction joints, which isolate the masonry wall from through-wall elements such as windows and doors.

Sealant selection

Some factors to consider when designing wall joints are the expansion characteristics of adjacent materials, the size and location of the joint, and the performance characteristics of the specified sealant. Since a joint is only as efficient as its sealant, a joint cannot properly be designed until the sealant has been selected. The selection should be based on a careful review and comparison of the following important characteristics:

- Positive expansive capability (i.e. +50 percent)
- Negative contractibility (i.e. –25 percent)
- Service life
- Material composition
- Compatibility with other materials
- Hardness
- Curing time
- UV resistance
- Weather and chemical resistance
- Substrate adhesion (need for priming)
- Material warranty
- Cost

The sealant's expansion/contraction capability should be specified on the product packaging, designated within material data sheets, or available from the manufacturer. This value denotes the percentage of the joint width to which the sealant can be stretched or compressed. Joint sealant extensibility typically ranges from 25 percent to 100 percent, depending upon material type, but can be as low as five percent in the case of inexpensive caulking.

Polyurethane sealants are a commonly used sealant in waterproofing applications due to their compatibility with most substrates and waterproofing materials. However, it is important that the specifier be aware of the differences between single component and multi-component sealants. Single component (aromatic or moisture cure) or multiple component (aliphatic or chemical cure) composition usually has a performance effect on sealant extensibility. Single component is the process whereby the material attains its final performance properties through evaporation; multiple component is the process whereby the material attains its final performance properties through chemical reactions or catalyst. Generally, a multi-component chemically-curing sealant possesses

a lower modulus increasing the materials movement capability. Optional sealant materials include:

- Acrylic
- Acrylic/Latex
- Butyl
- Latex
- Polysulfide
- Polyurea
- Silicone
- Silyl-Terminated Polyether

Climate and season play an important role in sealant durability. In fact, application in different temperatures can greatly affect the performance and life expectancy of the sealant. Since a joint is at its narrowest during hot weather, sealant applied at this time is subjected to tension throughout most of the year, which can lead to premature cohesive or adhesive failure.

If sealant is applied during the coldest winter months when the joint is at its widest, the material will be compressed for the balance of the year. This will tend to deform the sealant so it pulls away from the wall in an adhesive failure when the joint widens again during cold weather.

To avoid these types of failures, it may seem obvious to apply sealants only when temperatures and joint widths are at their mean averages. This, however, is not always achievable, due to construction schedules and other varying influences yet to occur, such as moisture swell and shrinkage. Recommendations for proper design and application that will help prevent adhesive and cohesive failures in sealants include:

- Designing a wider joint to avoid forcing the sealant to perform to the limit of its expansion/contraction range.
- Ensuring all joint substrates are clean and moisture-free.
- Providing a consistent joint geometry when practical.
- Using manufacturer-recommended primers, backer materials, and bond breakers.
- Maintaining consistent sealant depth-to-width ratios during application, typically between 1:2 and 1:1.
- Applying sealant material within its recommended temperature range, with respect to surface and ambient temperatures.
- Mixing multi-component materials thoroughly and consistently.
- Avoiding 'over-tooling' or 'stretching' sealant material during application.

Very often, sealant or joint design failures are the result of improper spacing and sizing of joints. Building joints are frequently arranged for aesthetic reasons, and engineering

calculations for establishing sufficient spacing and quantity of joints are overlooked. A good strategy to include within any building joint design is to consult with several sealant manufacturers to ensure that the selected sealant products will meet the specific installation requirements.

Notes

- 1 The crystallization of salts in the pores of wall systems can produce stresses that may damage the structure.
- 2 Movement under a sustained load over time.

Additional information

MasterFormat No.

04090—Masonry Accessories

04210—Clay Masonry Units

04220—Concrete Masonry Units

07920—Joint Sealants

UniFormat No.

B2010—Exterior Wall Exterior Skin

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Abstract

In this article, the author discusses the stresses and other problems that plague clay and concrete brick masonry over the long term, and how to minimize them through careful sealant selection.