Designation: C1472 – 16$^{\varepsilon 1}$

Standard Guide for Calculating Movement and Other Effects When Establishing Sealant Joint Width[1]

This standard is issued under the fixed designation C1472; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—In the last line of 4.4 the word "predicted" was corrected editorially to "predicated" in November 2019.

1. Scope

1.1 This guide provides information on performance factors such as movement, construction tolerances, and other effects that should be accounted for to properly establish sealant joint size. It also provides procedures to assist in calculating and determining the required width of a sealant joint enabling it to respond properly to those movements and effects. Information in this guide is primarily applicable to single- and multi-component, cold-applied joint sealants and secondarily to precured sealant extrusions when used with properly prepared joint openings and substrate surfaces.

1.2 Although primarily directed towards the understanding and design of sealant joints for walls for buildings and other areas, the information contained herein is also applicable to sealant joints that occur in horizontal slabs and paving systems as well as various sloped building surfaces.

1.3 This guide does not describe the selection and properties of joint sealants (**1**)[2], nor their use and installation, which is described by Guide C1193.

1.4 For protective glazing systems that are designed to resist blast and other effects refer to Guide C1564 in combination with this guide.

1.5 This guide is not applicable to the design of joints sealed with aerosol foam sealants.

1.6 For structural sealant glazing systems refer to Guide C1401 in combination with this guide.

1.7 The values and calculations stated in SI units are to be regarded as the standard. The values given in parentheses and inch-pound units are provided for information only. SI units in this guide are in conformance with IEEE/ASTM SI 10-1997.

1.8 The Committee having jurisdiction for this guide is not aware of any comparable standards published by other organizations.

1.9 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C216 Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
C717 Terminology of Building Seals and Sealants
C719 Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
C794 Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
C920 Specification for Elastomeric Joint Sealants
C1193 Guide for Use of Joint Sealants
C1401 Guide for Structural Sealant Glazing
C1481 Guide for Use of Joint Sealants with Exterior Insulation and Finish Systems (EIFS)
C1518 Specification for Precured Elastomeric Silicone Joint Sealants
C1523 Test Method for Determining Modulus, Tear and Adhesion Properties of Precured Elastomeric Joint Sealants

[1] This guide is under the jurisdiction of ASTM Committee C24 on Building Seals and Sealants and is the direct responsibility of Subcommittee C24.10 on Specifications, Guides and Practices.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this standard.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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2.2 The tables included in this guide are based on the reference version (year) outlined below. The references may not represent the most recent version of these standards based on publication dates and update intervals of these external references. Updates to these standards may have been published at intervals inconsistent with updates to this standard. Evaluation of accurate properties and data for the materials and the locale of the project are recommended.

2.3 *American Concrete Institute (ACI), American Society of Civil Engineers (ASCE), and The Masonry Society (TMS):*[4]

Building Code Requirements for Masonry Structures (ACI 530-02/ASCE 5-02/TMS 401-02) Reported by the Masonry Standards Joint Committee (MSJC)

2.4 *Prestressed Concrete Institute (PCI):*[5]

Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products, MNL-177-77

2.5 *American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):*[6]

Chapter 27, Climatic Design Information, Tables 1A, 1B, 2A, 2B, 3A, 3B, ASHRAE 2002 Fundamentals Handbook

2.6 *Brick Industry Association (BIA):*[7]

Volume Changes, and Effects of Movement, Part I, Technical Notes on Brick Construction, No. 18, Reissued Sept. 2000

2.7 *Institute of Electrical and Electronics Engineers, Inc. (IEEE) and ASTM:*[3]

IEEE/ASTM SI 10-2002 Standard for Use of the International System of Units (SI): The Modern Metric System

3. Terminology

3.1 *Definitions:*

3.1.1 Refer to Terminology C717 for definitions of the terms used in this guide.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *coefficient of linear thermal movement*—an increase or decrease in unit length per unit change in material temperature of a material or assembly of materials.

3.2.2 *coefficient of solar absorption*—a factor describing the capability of a material or assembly of materials to absorb a percentage of incident solar radiation.

3.2.3 *heat capacity constant*—a factor describing the capability of a material or assembly of materials to store heat generated by absorbed solar radiation.

3.3 *Symbols:*

α = Coefficient of linear thermal movement
α_B = Coefficient of linear thermal movement for brick
α_X = Coefficient of linear thermal movement for a particular material
A = Coefficient of solar absorption
A_B = Coefficient of solar absorption for brick
A_X = Coefficient of solar absorption for a particular material
B = Sealant backing length
C = Compression
C_B = Construction tolerance for brick masonry
C_X = Construction tolerance for a particular material or system
E = Extension
E_L = Longitudinal extension
E_T = Transverse extension
E_X = Longitudinal or transverse movement for a particular condition
H = Heat capacity constant
H_X = Heat capacity constant for a particular material
I = Moisture-induced irreversible growth
L = Unrestrained length or sealant joint spacing
ΔL_B = Dimensional change due to brick thermal movement
ΔL_C = Dimensional change due to compression
ΔL_E = Dimensional change due to extension
ΔL_I = Dimensional change due to irreversible moisture movement
ΔL_L = Dimensional change due to longitudinal extension
ΔL_P = Dimensional change due to precast concrete thermal movement
ΔL_R = Dimensional change due to reversible moisture movement
ΔL_T = Dimensional change due to transverse extension
ΔL_X = Dimensional change for a particular condition
R = Moisture induced reversible growth
S = Sealant movement capacity
T_A = Hottest summer air temperature
T_{IS} = Maximum summer installation wall surface temperature
T_{IW} = Minimum winter installation wall surface temperature
T_S = Hottest summer wall surface temperature
T_W = Coldest winter wall surface temperature
ΔT_M = Maximum expected temperature difference
ΔT_S = Summer installation temperature difference
ΔT_W = Winter installation temperature difference
ΔT_X = Temperature difference for a particular condition
W = Final designed sealant joint width
W_M = Sealant joint width required for movement
W_R = Sealant joint width at rest prior to movement

4. Significance and Use

4.1 Design professionals, for aesthetic reasons, have desired to limit the spacing and width of sealant joints on exterior walls and other locations of new buildings. Analysis of the performance factors and especially tolerances that affect a sealant joint is necessary to determine if a joint will have durability and be effective in maintaining a seal against the passage of air and water and not experience premature deterioration. If performance factors and tolerances are not understood and

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[4] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333, American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191 and The Masonry Society, 3970 Broadway, Suite 201-D, Boulder, CO 80304-1135.

[5] Available from the Prestressed Concrete Institute (PCI), 209 W. Jackson Blvd. #500, Chicago, IL 60606.

[6] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329.

[7] Available from Brick Industry Association (BIA), formerly Brick Institute of America, 11490 Commerce Park Dr., Reston, VA 20191-1525.

included in the design of a sealant joint, then the sealant may reach its durability limit and failure is a distinct possibility.

4.2 Sealant joint failure can result in increased building energy usage due to air infiltration or exfiltration, water infiltration, and deterioration of building systems and materials. Infiltrating water can cause spalling of porous and friable building materials such as concrete, brick, and stone; corrosion of ferrous metals; and decomposition of organic materials, among other effects. Personal injury can result from a fall incurred due to a wetted interior surface as a result of a failed sealant joint. Building indoor air quality can be affected due to organic growth in concealed and damp areas. Deterioration is often difficult and very costly to repair, with the cost of repair work usually greatly exceeding the original cost of the sealant joint work.

4.3 This guide is applicable to sealants with an established movement capacity, in particular elastomeric sealants that meet Specification C920 with a minimum movement capacity rating of ± 12½ percent. In general, a sealant with less than ± 12½ percent movement capacity can be used with the joint width sizing calculations; however, the width of a joint using such a sealant will generally become too large to be practically considered and installed. It is also applicable to precured sealant extrusions with an established movement capacity that meets Specification C1518.

4.4 The intent of this guide is to describe some of the performance factors and tolerances that are normally considered in sealant joint design. Equations and sample calculations are provided to assist the user of this guide in determining the required width and depth for single and multi-component, liquid-applied sealants when installed in properly prepared joint openings. The user of this guide should be aware that the single largest factor contributing to non-performance of sealant joints that have been designed for movement is poor workmanship. This results in improper installation of sealant and sealant joint components. The success of the methodology described by this guide is predicated on achieving adequate workmanship.

4.5 Joints for new construction can be designed by the recommendations in this guide as well as joints that have reached the end of their service life and need routine maintenance or joints that require remedial work for a failure to perform. Guide C1193 should also be consulted when designing sealant joints. Failure to install a sealant and its components following its guidelines can and frequently will result in failure of a joint design.

4.6 Peer reviewed papers, published in various ASTM Special Technical Publications (STP), provide additional information and examples of sealant joint width calculations that expand on the information described in this guide (**2-5**). For cases in which the state of the art is such that criteria for a particular condition is not firmly established or there are numerous variables that require consideration, a reference section is provided for further consideration.

4.7 To assist the user of this guide in locating specific information, a detailed listing of guide numbered sections and their headings is included in Appendix X1.

5. Performance Factors

5.1 *General*—Proper sealant joint design can not be adequately performed without a knowledge and understanding of factors that can affect sealant performance. The following describes most of the commonly encountered performance factors that are known to influence sealant joint design. These performance factors can act individually or, as is mostly the case, in various combinations depending on the characteristics of a particular joint design.

5.2 *Material and System Anchorage*—The type and location of various wall anchors has an impact on the performance of a sealant joint (**6**). Large precast concrete panels with fixed and moving anchors, brick masonry support system deflection between supports (**3**), and metal and glass curtain wall fixed and moving anchorages are examples of anchorage conditions that must be considered and evaluated when designing sealant joints for movement. Anchor types and their locations have an effect on determining the effective length of wall material or support system deflection characteristics that need to be included when designing for sealant joint width.

5.3 *Thermal Movement*—Walls of buildings respond to ambient temperature change, solar radiation, black-body radiation, wetting and drying effects from precipitation, and varying cloud cover by either increasing or decreasing in volume and therefore in linear dimension. The dimensional change of wall materials causes a change in the width of a sealant joint opening, producing a movement in an installed sealant. Thermal movement is the predominate effect causing dimensional change.

5.3.1 Depending on when a sealant is installed, thermal movement may need to be evaluated at different stages in a building's life; for example, expected temperature differentials may need to be considered for the building when it is: 1) under construction, 2) unoccupied and unconditioned, and 3) occupied and conditioned. Each of these stages will have different interior environmental conditions, and depending on the building enclosure material or system being analyzed for movement, one of those stages may produce the maximum expected thermal movement. The required joint opening width, depending on construction procedures and material or wall system types, could be established during one of those stages.

5.3.2 Determining realistic material or wall surface temperatures to establish the expected degree of thermal movement can be challenging. The ASHRAE Fundamentals Handbook, Chapter 14 Appendix Climatic Design Information, lists winter and summer design dry bulb air temperatures for many cities. These listed values can be used to assist in calculating expected surface temperatures for use in joint width calculations. For convenience, dry bulb air temperatures for selected North American locations have been included in Table 1 and for other World locations in Table 2.

5.4 *Thermal Movement Environmental Influences*—The effect of a sudden rain shower or the clouding over of the sky may also have to be considered (**6**). Both of these events can cause a wall material to change in temperature and therefore dimension. Moisture wetting a warm wall surface cools it and clouds preventing solar warming of the surface produce a