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Standard Guide for In-Situ Structural Silicone Glazing Evaluation¹

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INTRODUCTION

Structural Sealant Glazing (SSG) is a unique method of retaining glass or other panels via adhesive bonding using a structural sealant. Emerging in the mid-to-late 1960s, SSG applications used silicone sealants to transfer wind loads along two opposing sides of glass; a construction method which came to be known as “two-sided” SSG. By 1971, the technique began incorporating load transfer along all four sides of glass and the first “four-sided” SSG installation was built at 455 West Fort Street in Detroit, Michigan. Since then, buildings containing two- or four-sided (or, occasionally, other numbers of sides) SSG walls have been constructed within many cities, some exceeding 100 stories

While SSG popularity has increased since its inception, concerns remain over potential failures due to the increasing number of buildings constructed using this method that are aging; unknown overall structural sealant durability; and the fact that the adhesive bond in the SSG system remains largely concealed from visual inspection, creating concern on SSG systems in general. This guide addresses these concerns by providing suggestions for in-situ evaluations of completed installations of any age.

1. Scope

1.1 The existing condition of SSG installations should be periodically evaluated in-situ to detect if problems exist, and if so found, to address them before they become severe or pervasive. Evaluation of existing SSG installations is required by certain building codes and local ordinances. This guide provides a program to evaluate the existing conditions, lists typical conditions that may exist, and suggests times when such evaluations are appropriate. Presently, only a silicone sealant that is specifically formulated, tested and marketed as a structural glazing sealant is allowed for structural sealant glazing. The committee with jurisdiction over this standard is not aware of any comparable standards published by any other organizations.

1.2 *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.*

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. Referenced Documents

- 2.1 *ASTM Standards:*²
- C717 Terminology of Building Seals and Sealants
 - C1392 Guide for Evaluating Failure of Structural Sealant Glazing
 - C1401 Guide for Structural Sealant Glazing
 - C1521 Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints

3. Terminology

3.1 *Definitions:* The definitions of the following terms used in this guide are found in Terminology C717: structural sealant; structural sealant glazing; two-sided structural sealant glazing; four-sided structural sealant glazing; fluid migration.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *qualified person*—one with a recognized degree or professional registration and extensive knowledge and experience in the field of structural sealant glazing, and who is capable of design, analysis, evaluation, and interpretation of specifications in the subject.

² 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.

4. Significance and Use

4.1 Guidelines are provided for the procedures to evaluate existing SSG installations, including two- and four-sided installations. Due to the unlimited range of materials that may be used in a particular building, the information contained in this guide is general in nature. For a discussion of new SSG installations, refer to Guide C1401.

4.2 Typical conditions are listed that might be discovered during, or suggest the need for, such evaluations. Guidelines are also suggested for times to perform evaluations. These guidelines are also necessarily general. Professional judgment of a qualified person should be used in determining the appropriate time to perform an evaluation on a particular building.

4.3 This guide should not be the only reference consulted when determining the scope of a proposed evaluation. For example, the local building code and the manufacturers' product literature for the actual materials used (if known) should also be considered.

4.4 This document is not a substitute for experience and judgment in assessing the condition of the specialized types of construction discussed.

5. Reasons to Perform an Evaluation

5.1 There are numerous reasons that a building owner or manager (hereinafter "owner") may choose to evaluate an SSG system, whether discretionary or to comply with an ordinance. The recommended evaluation levels, as discussed in Section 7, are referenced for each situation. The findings from one level of investigation may trigger the need for a more in-depth investigation. At a minimum, it is recommended that an existing SSG installation be evaluated when triggered by any of the following events:

5.1.1 After a natural disaster, such as an earthquake or major wind storm, or a man-made disaster such as a bomb blast, Level 2;

5.1.2 After a recall or published concern over a specific product or system, Level 1;

5.1.3 Upon a change of property ownership, Level 1;

5.1.4 Before repeating a novel, unique or atypical design, Level 1;

5.1.5 As dictated by government regulations, Level 1 or 2; or

5.1.6 When distress is discovered (see Section 8), Level 2, or, if prevalent distress is found, Level 3.

5.2 In addition to event-triggered evaluations, it is recommended that proactive owners also perform periodic evaluations at the following intervals: (Note that some of these periods may overlap. If distress is found during any evaluation, then more frequent and more in-depth evaluations should be considered.)

5.2.1 When convenient, such as in conjunction with occasional glass replacement, or when access is available, Level 1;

5.2.2 Immediately after installation of a new system, Level 2;

5.2.3 Just before expiration of the warranty period, Level 2;

5.2.4 Between 1 and 2 years after substantial completion, Level 1;

5.2.5 After 5 years, Level 1;

5.2.6 After 10 years, Level 2;

5.2.7 After 15 years, Level 1 (if Level 2 was performed as recommended after 10 years); and

5.2.8 After 20 years, and each successive 10 years, Level 2.

6. Symptoms of Problems With SSG

6.1 Whether due to original construction mistakes or latent defects, SSG installations sometimes exhibit distress. The following list summarizes conditions that may indicate poor original construction or a subsequent failure of the structural sealant, and therefore require evaluation. This list may not be all-inclusive.

6.1.1 *Glass breakage from an unknown cause*—There are numerous potential causes of spontaneous glass breakage; if the cause is unknown, then it should be investigated prior to glass replacement whether an SSG defect contributed to the failure.

6.1.2 *Air or water infiltration*—If air or water migrates through or to the structural sealant joint, then it must also have lost its structural function—at least for part of its length. Symptoms of air or water leakage include:

6.1.2.1 Visible accumulation of liquid water during or following storms;

6.1.2.2 Wet insulation;

6.1.2.3 Organic growth;

6.1.2.4 Water stains or salt deposits;

6.1.2.5 Audible rattle or whistle;

6.1.2.6 Discoloration of laminated glazing;

6.1.2.7 Condensation or frost on glazing;

6.1.2.8 Fogging of insulated glass units;

6.1.2.9 *Opacifier failure on spandrel or other glass*—Moisture is a factor in the failure of some opacifiers, and may indicate water infiltration; and

6.1.2.10 *Visible sealant failures*—Sealant failures may be observed from inside or outside, depending on the design, and may involve the weather-seal joint as well as the structural joint. Visible manifestations of sealant failures include:

(1) *Intermittent loss of adhesion*—Nonadhered sealant may differ in iridescence or reflectivity compared to adhered sealant when viewed through the glass;

(2) *Fluid migration or exudation*—The accumulation of a fluid residue on the sealant or glass may indicate a chemical reaction between the sealant and an incompatible adjacent material;

(3) *Discoloration of the sealant*—A color change may indicate a chemical reaction between the sealant and an incompatible adjacent material;

(4) *Cohesive failure*—Although difficult to observe from inside or outside, cohesive failure could indicate overstressing of the sealant;

6.1.2.11 Disengaged or nonaligned lites, or displaced spacers or setting blocks, which may indicate glass displacement; and

6.1.2.12 *Poor dimensional control of a structural sealant joint*—When viewed from inside or outside, the structural

sealant should have uniform dimensions and full joints. Varying dimensions may indicate poor original installation practices, or improper/inadequate cure of the sealant.

7. Procedures for Evaluating Existing Conditions

7.1 The following evaluation procedures are recommended to be performed in determining the condition of an SSG installation. Depending on the reason for the evaluation and the type of installation, only certain procedures may be necessary; for example, more scrutiny is warranted for high-rise, 4-sided SSG than for low-rise, 2-sided SSG. The objective of the evaluation is to obtain a reasonable degree of confidence in the existing system, since one hundred percent certainty is not possible.

7.2 Different levels of expertise are needed to perform the various levels of evaluation, but in all cases a qualified person should supervise the evaluation.

7.3 *Level 1*—Perform all of the following evaluation procedures:

7.3.1 Review project record drawings/documents, including original design drawings, as-built drawings, shop drawings, mock-up testing report, and previous evaluation reports. Review original SSG design calculations, or if not available, perform calculations to determine stress on sealant from thermal and wind loading (and, where appropriate, seismic loading);

7.3.2 Review with building management, maintenance personnel, tenants, and any others with knowledge of the building's history, the breakage history of lites and other observed, suspected or known distress. Map findings on elevation drawings, and assess whether a pattern exists; and

7.3.3 Perform a cursory visual assessment from the interior, and from the exterior ground, roofs, setbacks, and balconies.

7.4 *Level 2*—Perform the following, plus all of the procedures of Level 1 (unless a Level 1 evaluation has been performed previously and the documentation recommended to be kept by the owner in 8.2 is available):

7.4.1 Perform close-up visual evaluation from the interior;

7.4.2 Observe weatherseal joints and structural joints from the exterior. Document distress, and assess whether a pattern exists. Utilize suitable optical tools (scope, binocular, magnifier, camera, drone, etc.) to assist in observing from remote viewing areas, or from suspended scaffolding. Choose scaffold “drops” to represent the entire building, including different wind zones, elevations, exposures, details, and construction times; and

7.4.3 Qualitatively evaluate the sealant adhesion by pressing in with a thumb or by the use of a rolling device as described in the Nondestructive Continuous Inspection Procedure in Practice C1521. Alternatively, semi-quantitative adhesion strength data can be obtained using a suitable spring load

indicator tool, or by pulling cut tabs to failure and measuring the elongation using the procedures and techniques outlined in Practice C1521.

7.5 *Level 3*—Perform all of the following procedures under the field supervision of a qualified person, plus the procedures of Levels 1 and 2 (except that Level 1 may be eliminated if it has been performed previously and the documentation recommended to be kept by the owner in 8.2 is available):

7.5.1 Consider whether the existing conditions indicate that evaluation of all lites is warranted. If not, develop a rational approach for evaluating a representative sample of the total lites. There is a trade-off between accuracy and the cost of the study. For quantitative tests and measurements, it is recommended that the number of specimens or tests be selected to ensure achieving at least a 90 % confidence interval with a maximum 20 % margin of error. Different levels of study may require stricter parameters; and

7.5.2 Perform in-situ load testing on selected lites, either by uniform load (air pressure) or point load (suction cups). One applicable test method is described in Guide C1392.

8. Report and Record Keeping

8.1 At the conclusion of the evaluation, a thorough report should be prepared presenting findings, conclusions, and, if appropriate, recommendations for remedial action.

8.2 It is recommended that the report(s) and evaluation data be maintained by the building owner in a standardized format to facilitate comparisons over time. For future reference it is recommended that all evaluation reports be kept together, along with other information pertinent to the SSG installation.

8.3 The report should provide the following information:

8.3.1 Building identification, background information, and references to original design and construction firms.

8.3.2 Purpose of evaluation, and triggering event or reason.

8.3.3 Evaluation procedures used, including referencing the specified levels of evaluation in this guide.

8.3.4 Availability and adequacy of original design and construction documentation, drawings, and calculations, especially in relation to current code requirements or state-of-the-art SSG design procedures.

8.3.5 Distress and defects observed.

8.3.6 Changes since last evaluation.

8.3.7 Field testing results. Record findings and test locations on elevation drawings.

8.3.8 Expected reliability of extrapolating the findings from limited areas to the entire system.

8.3.9 Recommendations for further evaluation or remedial action.

9. Keywords

9.1 distress; durability; glazing; structural glazing; structural sealant glazing; structural sealant joint; structural silicone; SSG; SSG design calculation; SSG design procedure; SSG evaluation; SSG installations