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Standard Guide for Conducting Inspections of Building Facades for Unsafe Conditions[1]

This standard is issued under the fixed designation E2841; 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.

1. Scope

1.1 This guide is intended to establish procedures and methodologies for conducting inspections of building facades including those that meet inspection criteria for compliance with Practice E2270. For the purposes outlined in this guide, unsafe conditions are hazards which could result from loss of facade materials.

1.2 Investigative techniques discussed may be intrusive, disruptive or destructive. It is the responsibility of the investigator to establish the limitations of use, to anticipate and advise of the destructive nature of some procedures, and to plan for patching and selective reconstruction as necessary.

1.3 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. Establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Awareness of safety and familiarity with safe procedures are particularly important for aboveground operations on the exterior of a building and destructive investigative procedures that typically are associated with the work described in this standard.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

E2270 Practice for Periodic Inspection of Building Facades for Unsafe Conditions

E2505 Practice for Industrial Rope Access

2.2 *SEI/ASCE Standards:*[3]

SEI/ASCE 7 Minimum Design Loads for Building and Other Structures

SEI/ASCE 37 Design Loads on Structures During Construction

3. Terminology

3.1 *Definitions*—For definitions of general terms, refer to Terminology E631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *facade*—a wall system including its exterior and interior components, fenestration, structural components, and components for maintaining the building interior environment (also called *building facade*).

3.2.2 *sheds:*

3.2.2.1 *sidewalk shed*—a shed erected along a sidewalk to protection pedestrians from overhead construction.

3.2.2.2 *light-duty shed*—a sidewalk shed designed to support a live-load of 150 psf and as such not intended for material or debris storage.

3.2.2.3 *heavy-duty shed*—a sidewalk shed designed to support a live-load of 300 psf and may be used for the storage of material or debris subject to weight limitations.

4. Significance and Use

4.1 This guide is intended to provide building professionals with a methodology for conducting periodic condition assessments of building facades, for the purpose of determining if conditions exist in the subject facades that represent hazards to persons or property. It addresses the performance expectations and service history of a facade, the various components of a facade, and the interaction between these components and adjacent construction to provide a stable and reliable enclosure system. This guide was written as a parallel document to Practice E2270. Practice E2270 is written in the imperative form as a Standard Practice and is designed for adoption by specifying authorities. This guide is intended as a dissemination of explicit knowledge gained from experience of conducting periodic facade inspections. Implicit in this guide are

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[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.

[3] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

general facade inspection techniques that have been tailored for periodic inspections. These tips and techniques are shared to provide a comprehensive template from which a facade inspection program can be tailored.

4.1.1 *Qualifications*—Use of this guide requires knowledge of basic physics, construction and building exterior wall design principles and practices.

4.1.2 *Application*—The sequential activities described herein are intended to produce a complete and comprehensive evaluation program, but all activities may not be applicable or necessary for a particular evaluation program. It is the responsibility of the professional using this guide to determine the activities and sequence necessary to perform an appropriate condition assessment for a specific building properly.

4.1.3 *Preliminary Assessment*—A preliminary assessment may indicate that localized conditions in a wall system exist which are limited to a specific element or portion of a wall. The evaluation of causes may likewise be limited in scope, and the procedures recommended herein abridged according to the professional judgment of the investigator. A statement stipulating the limits of the investigation should be included in the report.

4.1.4 *Expectations*—Expectations about the overall effectiveness of a condition assessment program must be reasonable, and in proportion to a defined scope of work and the effort and resources applied to the task. The scope and effort of facade inspections is defined by the purchaser and provider of such services. The objective is to be as comprehensive as possible within a defined scope of work. The methodology in this guide is intended to address the intrinsic behavior of a facade system. Since every location throughout the building facade is not likely to be included in the evaluation program, it is possible that localized conditions of distress may not be identified. Conditions that are localized or unique may remain, and require additional evaluation. The potential results and benefits of the condition assessment program should not be over-represented.

4.2 This guide is not intended for use as listed below. In each instance, more appropriate standards or guides exist.

4.2.1 As a design guide, design check, or a guide specification. Reference to design features of a wall is only for the purpose of identifying items of interest for consideration in the condition assessment process.

4.2.2 As a construction quality control procedure, or as a preconstruction qualification procedure.

4.2.3 As a diagnostic protocol for evaluating buildings for water leakage or other performance related problems.

4.2.4 As a sole evaluation of façade damage arising from natural or manmade event/disasters.

SYSTEMATIC APPROACH TO AN EVALUATION

5. Overview

5.1 The methodology presented in this guide is a systematic approach to evaluating the condition of exterior wall systems and is intended to be applicable to any wall system or material. The basic principles are not intended to be material or component specific. Appendices to this document address material and system specific considerations. The sequence of activities is intended to lead to an accumulation of information in an orderly and efficient manner, so that each step enhances and supplements the information gathered in the preceding step.

5.2 *Sequence of Activities*—The recommended sequence of activities, discussed in individual sections below, are:

5.2.1 Review of available documents,

5.2.2 Evaluation of design concept,

5.2.3 Evaluation of known service history,

5.2.4 Inspection, and

5.2.5 Analysis of findings.

5.3 *Analysis and Interpretation*—The information systematically gathered during a condition assessment is analyzed as it is acquired. The sequential activities described in this guide do not imply that analysis and interpretation of the information occurs only at the completion of all activities or at any specified time(s).

6. Review of Available Documents

6.1 Review available documents which may include original construction drawings, specifications, shop drawings, field reports, test reports, reference codes/standards, and previous facade assessment reports. Documents representing local trade practices as published by local trade groups may also exist.

6.2 *Design, Bidding, and Contract Documents*—These documents include architectural and engineering drawings, specifications, and may also include calculations, wind tunnel reports, correspondence, meeting minutes, addenda, substitution proposals, product literature, test reports, etc. They contain the information necessary to understand the performance criteria, the design intent, the required materials, and relationships among wall components according to the original design.

6.2.1 Documents may be revised or supplemented over the course of construction. Revisions to drawings are typically recorded by number and date, with a cross reference to other accompanying documents. Reviewing all revisions and issuances of the documents, and understanding the differences between them and the reason for the differences, is part of a comprehensive evaluation.

6.2.2 Documents with the most recent issue date and the highest revision number establish the final design requirements for the project. Ideally, a set of documents marked "as-built" or "record set" intended to show the actual construction will be available.

6.3 *Referenced Codes and Standards*—Project documents usually contain references to regulatory codes and industry standards. Standards and referenced codes often contain default or minimum criteria that might have been relied upon to establish the performance criteria for the facade. Conflicting requirements between referenced standards and codes, and those explicitly stated in the project documents, should not be assumed to be a cause of distress within a facade without further investigation.

6.3.1 Regulatory codes and industry standards change over time. The version of regulatory codes and industry standards examined as part of the review of project documents should be

those listed with dates in the project documents, or if not listed with dates, those in effect when the building permit was issued. Understanding the history and background of referenced codes and standards is part of a comprehensive evaluation.

6.4 *Submittals*—Additional documents are generally generated after the award of contracts, and are submitted to the design professional for review and inclusion in the project record. The submittals usually apply to a specific material, component, assembly or installation method, and the information contained will augment the background review. There are often a number of revisions to submittals prior to final approval. The standard for the project is set by the submittals approved by the design professional. Submittals include some or all of the following: shop drawings, test reports, product literature, manufacturers' recommendations, installation and maintenance guidelines, warranties, etc.

6.4.1 Test reports provided by manufacturers and suppliers should have been performed by an independent laboratory or witnessed by an independent agency. Review the test dates and the description of what was tested to determine if and how the information actually applies to the project.

6.4.2 Manufacturers' and suppliers' information, and the exclusionary language in warranties, may suggest circumstances under which a component may not function properly. Project conditions should be evaluated to determine if an appropriate product selection was made.

6.4.3 Submittals should be reviewed for maintenance recommendations and guidelines.

6.5 *Pre-Qualification: Laboratory Mock-Up and Onsite Mock-Up Reports*—Compliance with project requirements may have been demonstrated by a lab mock-up test. Mock-ups of complex facades rarely pass all tests on the first attempt. The mock-up report should contain a clear and complete description of changes made to pass the test. Project documents should incorporate these changes, and they should be reflected in the actual construction. Failure to incorporate changes should be considered as a potential causes of distress.

6.6 *Additional Construction, Field Inspections, and Field Testing Documents*—Additional construction documents which record changes, decisions and activities during the construction phase may include bulletins, requests for information (RFI), clarifications, change orders, directives, progress photos, field inspection reports, testing documentation and quality assurance reports, test reports, meeting minutes, and correspondence. The information in these documents may augment, modify, or supersede the design documents.

6.7 *Previous Facade Assessment Reports*—Some buildings may have been previously inspected in which case such reports should be reviewed.

6.8 *Local Workmanship Practices*—Knowledge of local and historical practices will permit a more thorough assessment of the project design and construction. The actual construction may be influenced in an undocumented manner by local practices.

6.9 *Missing Documents/Verification of Existing Documents*—Every reasonable effort should be made to verify existing as-built conditions regardless of the quantity or quality of existing documents.

6.10 *Understanding the Information Gathered:*

6.10.1 Reviewing the project documents should lead to a fundamental understanding of the constructed facades. Knowledge gained from reviewing the available documents should be utilized during subsequent tasks.

6.10.2 Where possible, utilize existing building elevation drawings or elevation/detail photographs to document related information for subsequent tasks.

7. Evaluation of Design Concept

7.1 *Performance Criteria*—Review of the available documents should reveal what performance requirements were specified for the wall and how the wall as an assembly and its individual components are structured. Alternatively, the requirements may have been implied through references to industry standards or local codes.

7.2 *Efficacy of the Design*—The facade design should be consistent with the performance criteria so that the desired performance can be achieved. The design should include properly selected components. The details should provide for the interfacing and integration of components so that each one can perform both individually and collectively as a system. The details should also address issues such as construction tolerances, material compatibilities, volume changes, and differential movement of the frame and the facade. A careful evaluation of the efficacy of the design relative to the performance criteria will indicate inconsistencies that may contribute to distress or failure of facade components.

7.2.1 The failure of a single facade component to perform at the specified level does not automatically mean that it was the cause of distress. In evaluating the overall wall, it should not be assumed that the cause of functional or physical distress is a single component simply because it does not satisfy stated or published performance requirements.

7.3 *Exposure*—The performance criteria in the project documents may have assumed exposure conditions that differ from actual exposure conditions of a subject building. Based on an analysis of local weather conditions, and the location and geometry of the building, identify the service conditions from the actual exposure. These conditions can be correlated with the service history, described in the next section, to help establish a protocol for the evaluation process.

7.4 *Understanding Design Intent*—Reviewing the design concept should lead to a fundamental understanding of the intended performance of the constructed facades. Knowledge gained from understanding the design intent should be utilized during subsequent tasks.

8. Determination of Service History

8.1 Gathering information on the service history serves several purposes. First, patterns in the observed behavior and visible damage can provide an indication of the cause(s) of behavior or damage, or both, and where to focus an investigation. Second, and more importantly, the information provides a checklist against which failure theories and conclusions can be evaluated.

8.2 *Interviews*—Interview occupants, maintenance personnel, subcontractors, tradesmen or other first-hand observers. Obtain information which will help correlate distress with building features and other events, such as:

8.2.1 Water leakage,

8.2.2 Unusual noise,

8.2.3 Condensation,

8.2.4 Glass breakage,

8.2.5 Dislocation or failure of wall components,

8.2.6 Thermal movements,

8.2.7 Moisture related expansion/contraction,

8.2.8 Cracking or spalling of components, and

8.2.9 Air infiltration or exfiltration.

8.3 *Maintenance, Repair, and Alteration Records*—Buildings with chronic facade problems are often subjected to several attempts at remediation before a comprehensive evaluation is made. An effort should be made to understand the earlier attempts at repairs because: (*1*) they may indicate a pattern of behavior, such as water leakage; (*2*) although well intended, repairs may be causing or contributing to continuing distress; and (*3*) it will be helpful to distinguish between original construction and attempted repairs during the inspection phases of a systematic evaluation. Where appropriate and possible:

8.3.1 Review the original, maintenance, repair, alteration, or a combination thereof, project closeout comments or "punch list" if available. Problems may occur early in the life of a building, and stop-gap repairs might have been made in an effort to close out the project.

8.3.2 Review purchase orders or contracts, or both, for building maintenance and repair. Consider roofing, caulking and sealants, pointing, painting, waterproofing, removing efflorescence or staining, and other activities that may relate to distress.

8.3.3 Review maintenance work orders which deal with recurring issues with the same performance problem.

8.3.4 Evaluate the performance of previous repair attempts.

8.3.5 Compare original details to actual conditions observed to determine deviations from original design intent or undocumented repair attempts.

8.3.6 Identify repairs or alterations that might have inadvertently sealed weep holes or other openings and paths intended to dissipate water. These might have been sealed in an attempt to stop leaks, and could exacerbate distress of internal and external wall components.

8.3.7 Evaluate the effect of attempted repairs on the original design intent. Common, but often ineffective, repairs made in response to water leaks in walls include the application of sealant and coating of exterior surfaces with clear water repellents or elastomeric coatings. Inappropriate use of these procedures can cause distress of components, such as:

8.3.7.1 Sealant installed at drainage paths which entrap water within the facade. The application of additional sealant should not be made prior to evaluation of the total facade except to correct obvious omissions. Entrapped water can lead to freeze/thaw damage, corrosion of internal and external components, and deterioration of water sensitive components.

8.3.7.2 Water repellents can affect the performances of future repairs, such as the adhesion of sealants or the bond of repointing mortar. These materials can also reduce the water vapor transmission rate of a wall assembly, affecting the weatherability of some materials.

8.3.7.3 Low permeance coatings will reduce the water vapor transmission rate of the facade and can increase the time required for water-saturated facades to dry. The application of these materials can increase the amount of entrapped water if other deficiencies exist.

8.4 Determine extent of known historic distress - Use the information gained above to determine the extent of known historic distress in the facade and indications of performance problems.

8.4.1 Attempt to correlate documented distress with specific building features and details.

8.4.2 A graphical analysis is useful for correlation studies. Distress and leakage occurrences can be superimposed on building elevation and plan drawings to help reveal patterns that might be traceable to specific types of details or component failures.

8.5 *Correlations*—Correlate known distress with other factors such as temperature and exposure.

8.5.1 *Temperature*—Ambient air temperature and wall surface temperature can greatly affect observed distress. Building joints (control and expansion) and cracks in facade materials are most likely at their widest when ambient temperatures are low, and their narrowest when surface temperatures are high.

8.6 *Understanding Service History*—Determining the service history should lead to a fundamental understanding of the past performance of the facade. Documented, relative information gathered and knowledge gained from determining the service history should be utilized during subsequent tasks.

9. Inspection

9.1 Inspections complement and extend the information gathered from the review of project documents and the service history. The major objectives of an inspection program are: to determine as-built conditions, determine the current condition of the wall including both visible and concealed component damage, and to formulate initial hypotheses about cause.

9.2 *Determine As-Built Conditions* —The various components of the facade, including the structural support system, thermal and condensation control systems, sealants, water control systems and connectors should all work together to provide the desired facade performance. Project drawings rarely depict the relationships among all of these components of a facade completely and accurately. The inspection process should result in a clear understanding of the relationships among all the parts of a facade.

9.2.1 *Presentation*—Composite large-scale drawings are helpful in gathering and recording information about as-built conditions. A composite drawing can begin with the best available information from the project documents, including pertinent information from the architectural and structural drawings and specifications, as well as the structural and wall component shop drawings. The investigator must correlate