Designation: E2099 – 23

Standard Practice for Specification and Evaluation of Pre-Construction Laboratory Mockups of Exterior Wall Systems[1]

This standard is issued under the fixed designation E2099; 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 standard practice covers procedures and documentation to assist in the specification and evaluation of pre-construction laboratory mockups of exterior wall systems.

1.2 This standard practice addresses design and construction of the mockup, observation during mockup construction and testing, evaluation of the mockup test results, and documentation of the mockup and testing process. Coordination is required between the parties involved in the design, construction, and testing of the mockup to facilitate this process. Documentation should convey the results of pre-construction mockups from one party to others at appropriate stages in the process.

1.3 This standard practice recommends the selection and order of individual tests performed on the mockup in the absence of a specific test order.

1.4 This standard practice recommends a protocol for exchange of information between participants in the pre-construction mockup process.

1.5 Responsibility for specific activities is recommended by this practice. This practice is intended to provide a default structure in the absence of the assignment of specific responsibilities by the specifying authority.

1.6 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.7 *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:*[2]

E283 Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

E330/E330M Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

E331 Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

E547 Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference

E631 Terminology of Building Constructions

E1233/E1233M Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Cyclic Air Pressure Differential

2.2 *AAMA, Fenestration and Glazing Industry Alliance (FGIA) Standards:*[3]

AAMA 501 Methods of Test for Exterior Walls

AAMA 501.1 Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure

AAMA 501.4 Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind-Induced Inter-Story Drifts

AAMA 501.5 Test Method for Thermal Cycling of Exterior Walls

AAMA 501.7 Recommended Static Test Method for Evaluating Windows, Window Wall, Curtain Wall and Storefront Systems Subjected to Vertical Inter-Story Movements

AAMA 501.9 Surface Temperature Assessment for Condensation Evaluation of Exterior Wall Systems

[1] This practice is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.55 on Performance of Building Enclosures.

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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 the Fenestration and Glazing Industry Alliance (FGIA), 1900 E Golf Rd, Suite 1250 Schaumburg, IL 60173, http://www.fgiaonline.org.

***A Summary of Changes section appears at the end of this standard**

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2.3 *ASCE/SEI Standard:*

ASCE/SEI 7 Minimum Design Loads and Associated Criteria for Buildings and Other Structures[4]

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology E631, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *builder*—the builder of the mockup and the exterior wall system.

3.2.2 *elastic design displacement*—the lateral displacements, as provided by the building engineer of record, determined by elastic analysis or other suitable method, after which serviceability of the envelope is to be maintained. If unspecified, elastic design displacement for testing shall be as specified in Section 7.0 of AAMA 501.4.

3.2.3 *inelastic seismic design displacement, Dp*—the lateral displacements, as provided by the building engineer of record, determined by elastic analysis and amplified by Cd/Ie (ASCE/SEI 7) but not exceeding the allowable story drift, Δa (ASCE/SEI 7).[4]

3.2.3.1 *Discussion*—If using a performance-based design, the maximum inelastic drift may be larger than the allowable story drift.

3.2.4 *pre-construction mockup*—a full-size representation of the proposed exterior wall system built before the exterior wall design is completed in order to study proposed construction details, test for performance and possibly judge appearance of the exterior wall system.

3.2.5 *specifier*—the architect or professional design party responsible for the design of the exterior wall system.

3.2.6 *test agency*—the selected agency to conduct the required tests.

4. Significance and Use

4.1 Exterior wall systems require time to design, fabricate, construct and test. Mockups are generally a full-size representative portion of the proposed exterior wall system built to study proposed construction details, test for performance, and in some cases judge appearance of the exterior wall system. The project schedule shall allow time to design, construct, and test the pre-construction mockup and to implement any design changes, fabrication changes, or modifications of planned construction procedures, before construction of the exterior wall system commences.

4.2 Performance testing of pre-construction mockups verifies compliance with specified standards and design criteria. Performance tests in separate ASTM or other industry standards, are intended to represent the effects of environmental conditions, such as wind, rain, and temperature extremes. The tests provide a measure of the performance of the proposed exterior wall system under specific and controlled conditions. The specified design and specification of the pre-construction mockup must be appropriate for the performance test requirements. Separate tests may be required for individual mockup materials or components.

4.3 Pre-construction mockup specimens require input from Specifier, Builder, and Test Agency. Coordination of their efforts facilitates this process. Documentation should convey the results of preconstruction mockups from one party to others at appropriate stages in the process.

4.4 The referenced standards provided in this practice identify the historical standards typically utilized in pre-construction performance testing. This practice allows for the development and use of other project specific test procedures for various components that encompass exterior wall systems.

5. Design

5.1 The Specifier is responsible for the requirements of this section, unless stated otherwise.

5.2 Provide sufficient information on the design documents to describe the materials, details and performance testing requirements of the mockup.

5.3 *Mockup Materials:*

5.3.1 All framing and cladding elements of the exterior wall system in accurate full size, orientation, and configuration.

5.3.2 Color and finish of materials, if the appearance of the mockup is to be judged.

5.3.3 Joints between components.

5.3.4 Thermal insulation, if thermal testing is specified.

5.3.5 Structural support and attachment of the exterior wall system to the building frame.

NOTE 1—Tolerances between elements of the exterior wail system and the building support should be considered and tested in a “worst-case” condition in the mockup.

5.4 *Mockup Systems*—Elements of the exterior wall system that are designed to control:

5.4.1 Air infiltration.

5.4.2 Water penetration.

5.4.3 Wind pressure.

5.4.4 Movements of wall system due to thermal effects, volumetric changes or building frame movements.

5.4.5 Seismic movements, if the building is in a seismically active region.

5.5 *Mockup Size*—The mockup shall be of sufficient size to represent the following typical elements of the exterior wall system including interior and exterior comers where appropriate. Refer to Section 8 of Test Methods E283, E330/E330M, and E331 for requirements of the test specimens.

NOTE 2—Confirm the maximum size mockup that the Test Agency can accommodate. In some projects, multiple mockups may be necessary to test all desired conditions of the project.

5.5.1 *Height*—Minimum one typical floor height plus an additional height so that typical horizontal conditions are represented. For exterior wall systems that have multi-floor structural elements or water control systems that occur on

[4] Available from American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, Virginia, 20191-4382, http://www.asce.org