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Standard Guide for Design of Earthen Wall Building Systems¹

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1. Scope

1.1 This standard provides guidance for earthen building systems that address both technical requirements and considerations for sustainable development. Earthen building systems include adobe, rammed earth, cob, cast earth and other earth technologies used as structural and non-structural wall systems.

1.1.1 There are many decisions in the design and construction of a building that can contribute to the maintenance of ecosystem components and functions for future generations, that is, sustainability. One such decision is the selection of products for use in the building. This standard addresses sustainability issues related to the use of earthen wall building systems.

1.1.2 The considerations for sustainable development relative to earthen wall building systems are categorized as follows: materials (product feedstock); manufacturing process; operational performance (product installed); and indoor environmental quality (IEQ).

1.1.3 The technical requirements for earthen building systems are categorized as follows: design criteria, structural and non-structural systems, and structural and non-structural components.

1.2 This standard does not provide guidance for structural support of roofs made of earthen material.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

¹ This guide is under the jurisdiction of ASTM Committee E60 on Sustainability and is the direct responsibility of Subcommittee E60.01 on Buildings and Construction.

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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.

C66/C66M Specification for Specification for Sand for Use in Lime Plaster³

D559 Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures

D560 Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures

D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³))

D5860 Test Method for Evaluation of the Effect of Water Repellent Treatments on Freeze-Thaw Resistance of Hydraulic Cement Mortar Specimens

E631 Terminology of Building Constructions

E2114 Terminology for Sustainability Relative to the Performance of Buildings

2.2 ASCE Standards:⁴

ANSI/ASCE 7 Minimum Design Loads for Buildings and Other Structures

3. Terminology

3.1 Definitions:

3.1.1 For terms related to building construction, refer to Terminology E631.

3.1.2 For terms related to sustainability relative to the performance of buildings, refer to Terminology E2114. Some of these terms are reprinted here for ease of use.

3.1.3 *alternative agricultural products, n*—bio-based industrial products (non-food, non-feed) manufactured from agricultural materials and animal by-products.

3.1.4 *biodegradable, adj*—capable of decomposing under natural conditions into elements found in nature.

3.1.5 *biodiversity, n*—the variability among living organisms from all sources including: terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.

³ Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

3.1.6 *ecosystem, n*—community of plants, animals (including humans), and their physical environment, functioning together as an interdependent unit within a defined area.

3.1.7 *embodied energy, n*—the energy used through the life cycle of a material or product to extract, refine, process, fabricate, transport, install, commission, utilize, maintain, remove, and ultimately recycle or dispose of the substances comprising the item.

3.1.7.1 *Discussion*—The total energy which a product may be said to “contain” including all energy used in, inter alia, growing, extracting, transporting and manufacturing. The embodied energy of a structure or system includes the embodied energy of its components plus the energy used in construction.

3.1.8 *renewable resource, n*—a resource that is grown, naturally replenished, or cleansed, at a rate which exceeds depletion of the usable supply of that resource.

3.1.8.1 *Discussion*—A renewable resource can be exhausted if improperly managed. However, a renewable resource can last indefinitely with proper stewardship. Examples include: trees in forests, grasses in grasslands, and fertile soil.

3.1.9 *sustainability, n*—the maintenance of ecosystem components and functions for future generations.

3.1.10 *sustainable development, n*—development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

3.1.11 *toxicity, n*—the property of a material, or combination of materials, to adversely affect organisms.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *adobe, n*—(1) unfired masonry units made of soil, water, and straw with or without various admixtures; (2) the soil/straw or soil/straw/admixtures mix that is used to make them; (3) the mud plaster used for covering walls or ceilings, or both; (4) the building that is built of adobe and; (5) the architectural style.

3.2.1.1 *Discussion*—The word itself is believed to come from an Arabic word *atob*, which means muck or sticky glob or *atubah* “the brick.” The adobe style of architecture migrated from North Africa to Spain, so the name adobe is likely to have come with it. In many other countries, the word adobe is meaningless, and it is more accurate to say “earthen-brick.” Other forms of the same material with different details and names, such as rammed earth, Pisé, Jacal, Barjareque, cob, or puddled mud are sometimes referred to as adobe.

3.2.2 *adobe construction, n*—construction in which the exterior load-bearing and the non-load-bearing walls and partitions are of unfired clay masonry units while the floors, roofs and interior framing may be wholly or partly of wood or other approved materials.

3.2.3 *adobe, stabilized, n*—unfired clay masonry units to which admixtures, such as emulsified asphalt or cement, are added during the manufacturing process to help limit water absorption and increase durability.

3.2.4 *adobe, unstabilized, n*—unfired clay masonry units that do not meet the definition of stabilized adobe.

3.2.5 *carbon sink, n*—a reservoir that absorbs or takes up released carbon from another part of the carbon cycle.

3.2.5.1 *Discussion*—For example, if the net exchange between the biosphere and the atmosphere is toward the atmosphere, the biosphere is the source, and the atmosphere is the sink

3.2.6 *cast earth, n*—a construction system utilizing a slurry containing soil, calcined gypsum and water, which is poured into forms similar to those used for cast-in-place concrete.

3.2.7 *clay, n*—inorganic soil with particle sizes less than 0.005 mm (0.0002 in.) having the characteristics of high to very high dry strength, medium to high plasticity and slow to no dilatancy.

3.2.8 *cob, n*—a construction system utilizing moist earthen material balls stacked on top of one another and lightly tapped into place to form monolithic walls. Reinforcing is often provided with organic fibrous materials such as straw and twigs.

3.2.9 *earthen building systems, n*—building systems that utilize soil as the principal structural material.

3.2.10 *energy efficient, adj*—refers to a product that requires less energy to manufacture or uses less energy when operating in comparison with a benchmark for energy use, or both.

3.2.10.1 *Discussion*—For example, the product may meet a recognized benchmark, such as the EPA’s Energy Star Program standards.

3.2.11 *gravel, n*—inorganic soil with particle sizes greater than 2 mm (0.079 in.).

3.2.12 *horizon, n*—distinctive layer of in situ soil having uniform qualities of color, texture, organic material, obliteration of original rock material, and more.

3.2.12.1 *Discussion*—In *World Reference Base for Soil Resources*, by the Food and Agriculture Organization of the United Nations, seven master horizons are recognized – H, O, A, E, B, C, and R.

3.2.13 *indoor environmental quality (IEQ), n*—refers to the condition or state of the indoor built environment in which the building product is installed. Aspects of IEQ include: light quality, acoustic quality, and air quality.

3.2.14 *loam, n*—soil with a high percentage of organic material, particles are predominately silt size but range from clay size to sand size.

3.2.14.1 *Discussion*—Loams are usually good agricultural soils due to their nutritional organic content and their ability to hold water.

3.2.15 *manufacturing process, n*—refers to the process of creating a building product and includes manufacturing, fabrication and distribution procedures.

3.2.16 *materials (product feedstock), n*—refers to the material resources that are required for the manufacture or fabrication, or both, of a building product.

3.2.16.1 *Discussion*—Material resources include raw materials and recycled content materials.

3.2.17 *moisture wicking*—the capillary uptake of water from foundation soil, ambient humidity or precipitation. Moisture wicking can result in saturation of adobe with an accompanying decrease in strength and durability.

3.2.18 *operational performance (product installed), n*—refers to the functioning of a product after it is installed.