

2021 Virginia Construction Code

CHAPTER 21 MASONRY

SECTION 2109 EMPIRICAL DESIGN OF ADOBE MASONRY

2109.1 General.

Empirically designed adobe masonry shall conform to the requirements of Appendix A of [TMS 402](#), except where otherwise noted in this section.

2109.1.1 Limitations.

The use of empirical design of adobe masonry shall be limited as noted in Section A.1.2 of [TMS 402](#). In buildings that exceed one or more of the limitations of Section A.1.2 of [TMS 402](#), masonry shall be designed in accordance with the engineered design provisions of [Section 2101.2](#) or the foundation wall provisions of [Section 1807.1.5](#).

Section A.1.2.2 of [TMS 402](#) shall be modified as follows:

A.1.2.2 – *Wind*. Empirical requirements shall not apply to the design or construction of masonry for buildings, parts of buildings, or other structures to be located in areas where V_{asd} as determined in accordance with [Section 1609.3.1](#) of the *International Building Code* exceeds 110 mph.

2109.2 Adobe construction.

Adobe construction shall comply with this section and shall be subject to the requirements of this code for Type V construction, Appendix A of [TMS 402](#), and this section.

2109.2.1 Unstabilized adobe.

Unstabilized adobe shall comply with [Sections 2109.2.1.1](#) through [2109.2.1.4](#).

2109.2.1.1 Compressive strength.

Adobe units shall have an average compressive strength of 300 psi (2068 kPa) when tested in accordance with [ASTM C67](#). Five samples shall be tested and individual units are not permitted to have a compressive strength of less than 250 psi (1724 kPa).

2109.2.1.2 Modulus of rupture.

Adobe units shall have an average modulus of rupture of 50 psi (345 kPa) when tested in accordance with the following procedure. Five samples shall be tested and individual units shall not have a modulus of rupture of less than 35 psi (241 kPa).

2109.2.1.2.1 Support conditions.

A cured unit shall be simply supported by 2-inch-diameter (51 mm) cylindrical supports located 2 inches (51 mm) in from each end and extending the full width of the unit.

2109.2.1.2.2 Loading conditions.

A 2-inch-diameter (51 mm) cylinder shall be placed at midspan parallel to the supports.

2109.2.1.2.3 Testing procedure.

A vertical *load* shall be applied to the cylinder at the rate of 500 pounds per minute (37 N/s) until failure occurs.

2109.2.1.2.4 Modulus of rupture determination.

The modulus of rupture shall be determined by the equation:

$$f_r = 3 PL_s / [2 S_w (S_t^3)]$$

where, for the purposes of this section only:

(Equation 21-2)

S_w = Width of the test specimen measured parallel to the loading cylinder, inches (mm).

f_r = Modulus of rupture, psi (MPa).

L_s = Distance between supports, inches (mm).

S_t = Thickness of the test specimen measured parallel to the direction of load, inches (mm).

P = The applied *load* at failure, pounds (N).

2109.2.1.3 Moisture content requirements.

Adobe units shall have a moisture content not exceeding 4 percent by weight.

2109.2.1.4 Shrinkage cracks.

Adobe units shall not contain more than three shrinkage cracks and any single shrinkage crack shall not exceed 3 inches (76 mm) in length or $\frac{1}{8}$ inch (3.2 mm) in width.

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2109.2.2 Stabilized adobe.

Stabilized adobe shall comply with [Section 2109.2.1](#) for *unstabilized adobe* in addition to [Sections 2109.2.2.1](#) and [2109.2.2.2](#).

2109.2.2.1 Soil requirements.

Soil used for *stabilized adobe* units shall be chemically compatible with the stabilizing material.

2109.2.2.2 Absorption requirements.

A 4-inch (102 mm) cube, cut from a *stabilized adobe* unit dried to a constant weight in a ventilated oven at 212°F to 239°F (100°C to 115°C), shall not absorb more than 1½ percent moisture by weight when placed on a constantly water-saturated, porous surface for seven days. Not fewer than five specimens shall be tested and each specimen shall be cut from a separate unit.

2109.2.3 Allowable stress.

The allowable compressive stress based on gross cross-sectional area of adobe shall not exceed 30 psi (207 kPa).

2109.2.3.1 Bolts.

Bolt values shall not exceed those set forth in [Table 2109.2.3.1](#).

**TABLE 2109.2.3.1
ALLOWABLE SHEAR ON BOLTS IN ADOBE MASONRY**

DIAMETER OF BOLTS (inches)	MINIMUM EMBEDMENT (inches)	SHEAR (pounds)
1/2	—	—
5/8	12	200
3/4	15	300
7/8	18	400
1	21	500
1 1/8	24	600

For SI: 1 inch = 25.4 mm, 1 pound = 4.448 N.

2109.2.4 Detailed requirements.

Adobe construction shall comply with [Sections 2109.2.4.1](#) through [2109.2.4.9](#).

2109.2.4.1 Number of stories.

Adobe construction shall be limited to buildings not exceeding onestory, except that two-story construction is allowed where designed by a *registered design professional*.

2109.2.4.2 Mortar.

Mortar for *adobe construction* shall comply with [Sections 2109.2.4.2.1](#) and [2109.2.4.2.2](#).

2109.2.4.2.1 General.

Mortar for *adobe* units shall be in accordance with [Section 2103.2.1](#), or be composed of *adobe soil* of the same composition and stabilization as the *adobe brick* units. *Unstabilized adobe soil mortar* is permitted in conjunction with *unstabilized adobe brick* units.

2109.2.4.2.2 Mortar joints.

Adobe units shall be laid with full head and *bed joints* and in full *running bond*.

2109.2.4.3 Parapet walls.

Parapet walls constructed of *adobe* units shall be waterproofed.

2109.2.4.4 Wall thickness.

The minimum thickness of *exterior walls* in one-story buildings shall be 10 inches (254 mm). The walls shall be laterally supported at intervals not exceeding 24 feet (7315 mm). The minimum thickness of interior *load-bearing walls* shall be 8 inches (203 mm). The unsupported height of any wall constructed of *adobe* units shall not exceed 10 times the thickness of such wall.

2109.2.4.5 Foundations.

Foundations for *adobe construction* shall be in accordance with [Sections 2109.2.4.5.1](#) and [2109.2.4.5.2](#).

2109.2.4.5.1 Foundation support.

Walls and partitions constructed of *adobe* units shall be supported by foundations or footings that extend not less than 6 inches (152 mm) above adjacent ground surfaces and are constructed of *solid masonry* (excluding *adobe*) or concrete. Footings and foundations shall comply with [Chapter 18](#).

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2109.2.4.5.2 Lower course requirements.

Stabilized adobe units shall be used in adobe walls for the first 4 inches (102 mm) above the finished first-floor elevation.

2109.2.4.6 Isolated piers or columns.

Adobe units shall not be used for isolated piers or columns in a load-bearing capacity. Walls less than 24 inches (610 mm) in length shall be considered to be isolated piers or columns.

2109.2.4.7 Tie beams.

Exterior walls and *interior load-bearing walls* constructed of adobe units shall have a continuous tie beam at the level of the floor or roof bearing and meeting the following requirements.

2109.2.4.7.1 Concrete tie beams.

Concrete tie beams shall be 6 inches (152 mm) or more in depth and 10 inches (254 mm) or more in width. Concrete tie beams shall be continuously reinforced with not fewer than two No. 4 reinforcing bars. The specified compressive strength of concrete shall be not less than 2,500 psi (17.2 MPa).

2109.2.4.7.2 Wood tie beams.

Wood tie beams shall be solid or built up of lumber having a nominal thickness of not less than 1 inch (25 mm), and shall have a depth of not less than 6 inches (152 mm) and a width of not less than 10 inches (254 mm). Joints in wood tie beams shall be spliced not less than 6 inches (152 mm). Splices shall not be allowed within 12 inches (305 mm) of an opening. Wood used in tie beams shall be *approved* naturally decayresistant or *preservative-treated wood*.

2109.2.4.8 Exterior finish.

Exterior finishes applied to adobe masonry walls shall be of any type permitted by this section or Chapter 14, except where stated otherwise in this section.

2109.2.4.8.1 Where required.

Unstabilized adobe masonry walls shall receive a weather protective exterior finish in accordance with Section 2109.2.4.8.

2109.2.4.8.2 Vapor permeance.

Plaster and finish assemblies shall have a vapor permeance of not less than 5 perms.

Exception: Insulation products applied to the exterior of *stabilized adobe* masonry walls in Climate Zones 2B, 3B, 4B and 5B shall not have a vapor permeance requirement.

2109.2.4.8.3 Plaster thickness and coats.

Plaster applied to adobe masonry shall be not less than $\frac{7}{8}$ inch (22 mm) and not greater than 2 inches (51 mm) thick. Plaster shall be applied in not less than two coats.

2109.2.4.8.4 Plaster application.

Where plaster is applied directly to adobe masonry walls, no intermediate membrane shall be used.

2109.2.4.8.5 Lath for plaster.

Lath shall be provided for all plasters, except where not required elsewhere in Section 2109.2.4.8. Fasteners shall be corrosion resistant and spaced at a maximum of 16 inches (406 mm) on center with a minimum $1\frac{1}{2}$ -inch (38 mm) penetration into the adobe wall. Metal lath shall comply with ASTM C1063, as modified by this section, and shall be corrosion resistant. Plastic lath shall comply with ASTM C1788, as modified by this section. Wood substrates shall be protected with No. 15 asphalt felt, an approved wood preservative or other protective coating prior to lath application.

2109.2.4.8.6 Cement plaster.

Cement plaster shall conform to ASTM C926 and shall comply with Chapter 25, except that the proportion of lime in plaster coats shall be not less than 1 part lime to 4 parts cement. The combined thickness of *cement plaster* coats shall not exceed 1 inch (25 mm).

2109.2.4.8.7 Lime plaster.

Lime plaster is any plaster with a binder composed of calcium hydroxide, including Type N or S hydrated lime, hydraulic lime, natural hydraulic lime, or slaked quicklime. Hydrated lime shall comply with ASTM C206. Hydraulic lime shall comply with ASTM C1707. Natural hydraulic lime shall comply with ASTM C141 and EN 459. Quicklime shall comply with ASTM C5.

2109.2.4.8.8 Cement-lime plaster.

Cement-lime plaster shall be any plaster mix type CL, F or FL, as described in ASTM C926.

2109.2.4.8.9 Clay plaster.

Clay plaster shall comply with this section.

2109.2.4.8.9.1 General.

Clay plaster shall be any plaster having a clay or clay subsoil binder. Such plaster shall contain sufficient clay to fully bind

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the aggregate and shall be permitted to contain reinforcing fibers. Acceptable reinforcing fibers include chopped straw, sisal, and animal hair.

2109.2.4.8.9.2 Clay subsoil requirements.

The suitability of clay subsoil shall be determined in accordance with the Figure 2 Ribbon Test and the Figure 3 Ball Test in the appendix of ASTM E2392/E2392M.

2109.2.4.8.9.3 Weather-exposed locations.

Clay plaster exposed to water from direct or wind-driven rain or snow shall be finished with an approved erosion-resistant finish. The use of clay plasters shall not be permitted on weather-exposed parapets.

2109.2.4.8.9.4 Prohibited finish coat.

Plaster containing Portland cement shall not be permitted as a finish over clay plaster.

2109.2.4.8.9.5 Conditions where lathing is not required.

For *unstabilized adobe* walls finished with unstabilized clay plaster, lathing shall not be required.

2109.2.4.9 Lintels.

Lintels shall be considered to be structural members and shall be designed in accordance with the applicable provisions of [Chapter 16](#).