

Fire Resistant Earthen Building Materials

WUI Working Group Presentation
September 17, 2025



CA Governor's Office of
**Land Use and
Climate Innovation**



**CALIFORNIA STRATEGIC
GROWTH COUNCIL**

Objectives

- Share initial data, fire testing, and characteristics of earthen building materials
- Learn about OSFM work on fire resilience and nature-based solutions.
- Find opportunities for collaboration to advance earthen building as part of state-wide fire response strategy.
- Consider code recommendations to increase Californians' access to additional fire-resistant building materials.



Why We're Here

SGC

- **SB 732 (2008):** Statutory mandate
- **Council Priority 3:** Housing, Climate, Equity (Housing as a Climate Strategy)

LCI

- **Upcoming Long-Range Planning:** Environmental and economic goals
- **Upcoming Bioregional Planning:** Advance nature-based solutions
- **Wildfire And Forest Resilience Action Plan (2021):** Fire Adapted Communities Work Group.

OTHER

- **AB-1757 (2022):** Natural Working Lands, in line with EO to advance nature-based solutions
- **CARB Scoping Plan (2022):** Carbon sequestration strategies
- **State Climate Adaptation Strategy (2021):** Advance nature-based solutions
- **Title 24 Part 7 Update (2025)**



Earthen Building Materials



Monolithic
Adobe



Hemp-lime



Strawbale



Light Straw
Clay



Rammed
earth



Compressed
Earth Block

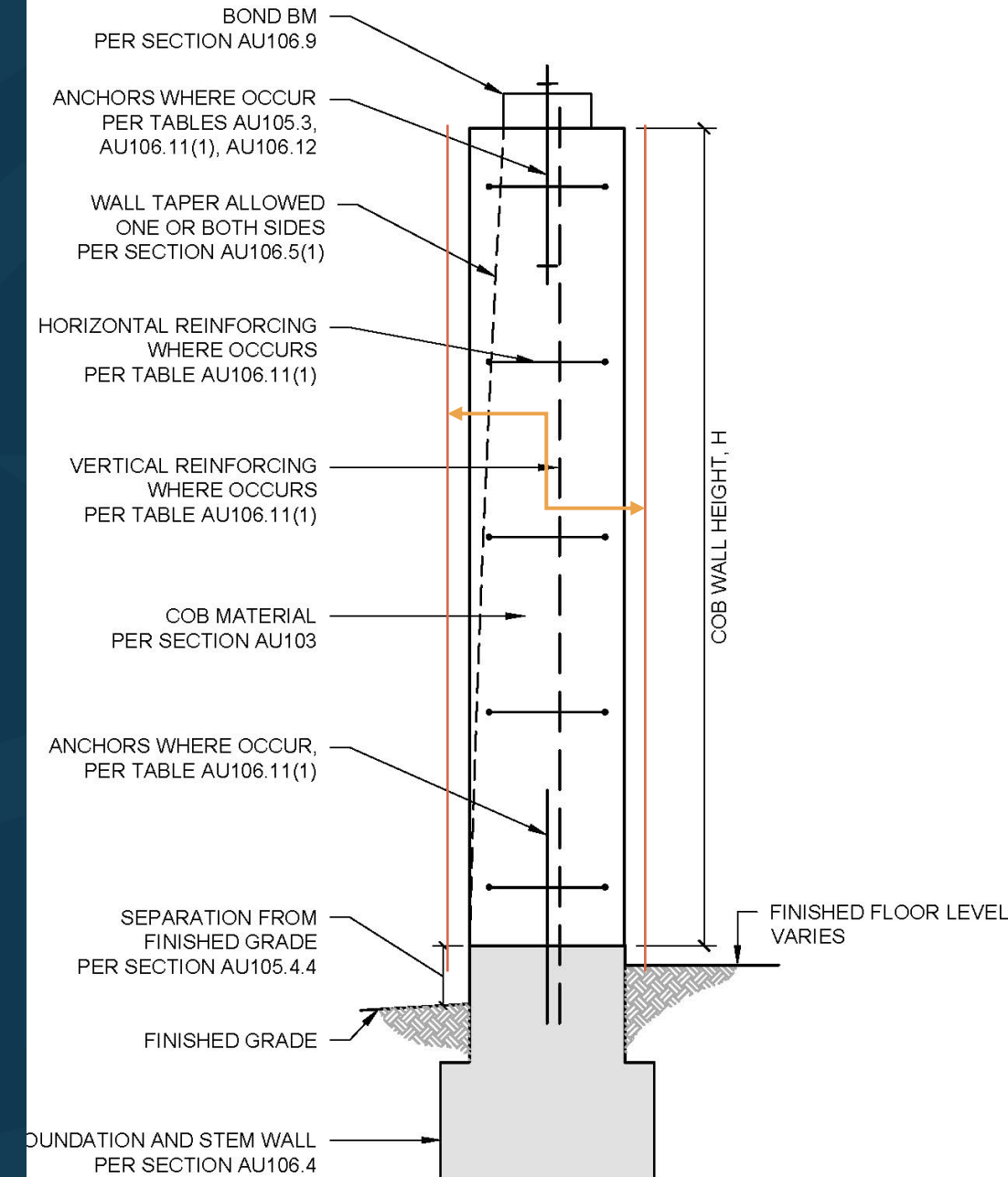


Heavy
Timber/CLT



Monolithic Adobe (Cob)

- Among the most fire resilient materials on earth.
- A mixture of dense packed clay, straw, sand, and water, which acts as the load-bearing structural wall.
- Clay entrains straw to make it extremely fire resistant, aided by exterior clay or lime plaster finish. Vitrifies when exposed to high heat.
- **Fully monolithic, fire-resistant, non-toxic wall.**
- Seals well across joints and does not lose strength when heated.
- Can be retrofitted over existing siding to increase ignition resistance (further study needed).

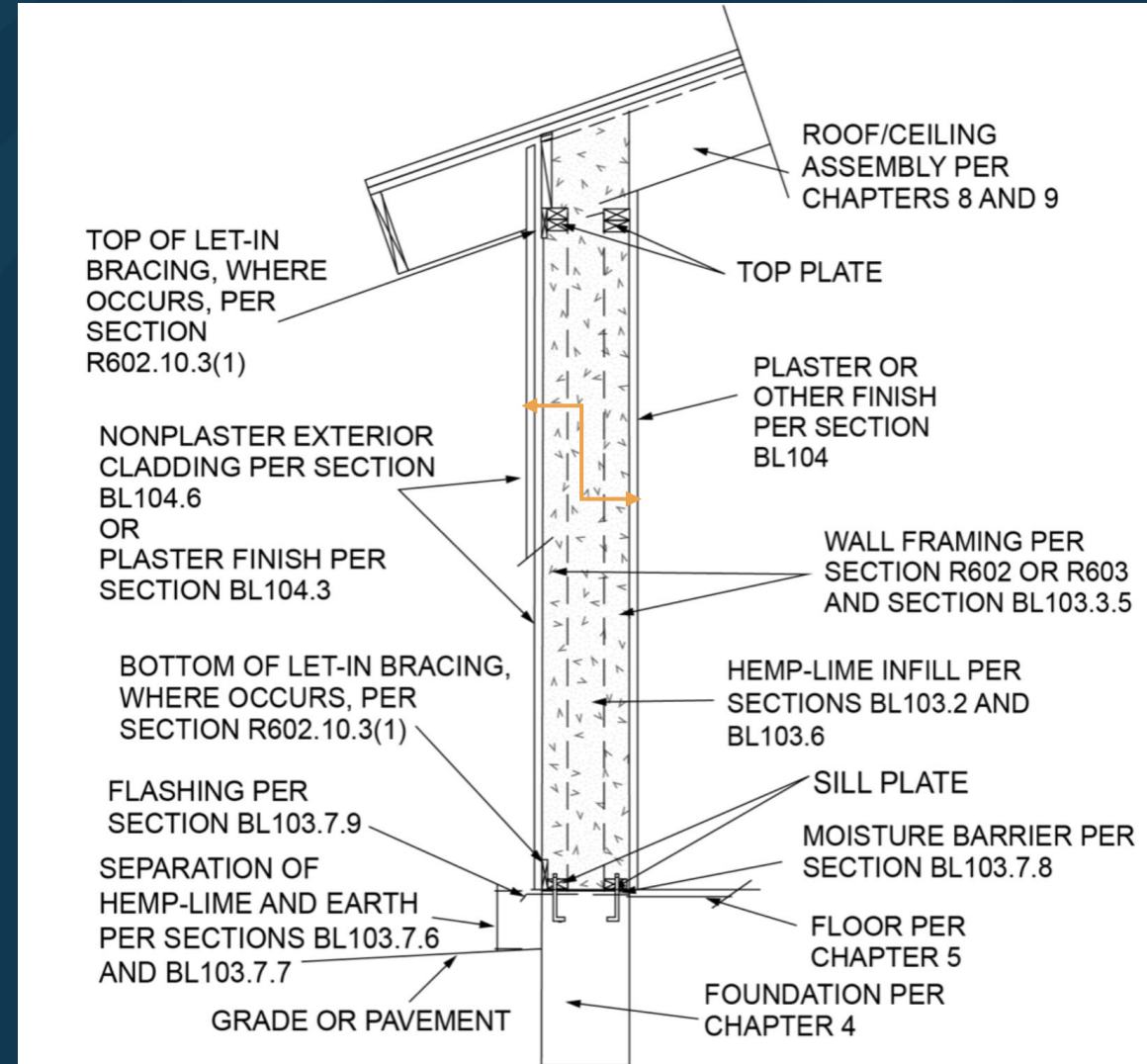


Monolithic Adobe (Cob)



Hemp-lime

- Non-load bearing bio-composite insulation material infill made of hemp hurd (shiv), water, and lime.
- Two applications: sprayed or assembled in blocks.
- **Finished with lime or clay plaster, creating fully fire-resistant, non-toxic wall.**
- High silica content in hemp fiber is naturally fire resistant.
- Good for both new construction and retrofits.

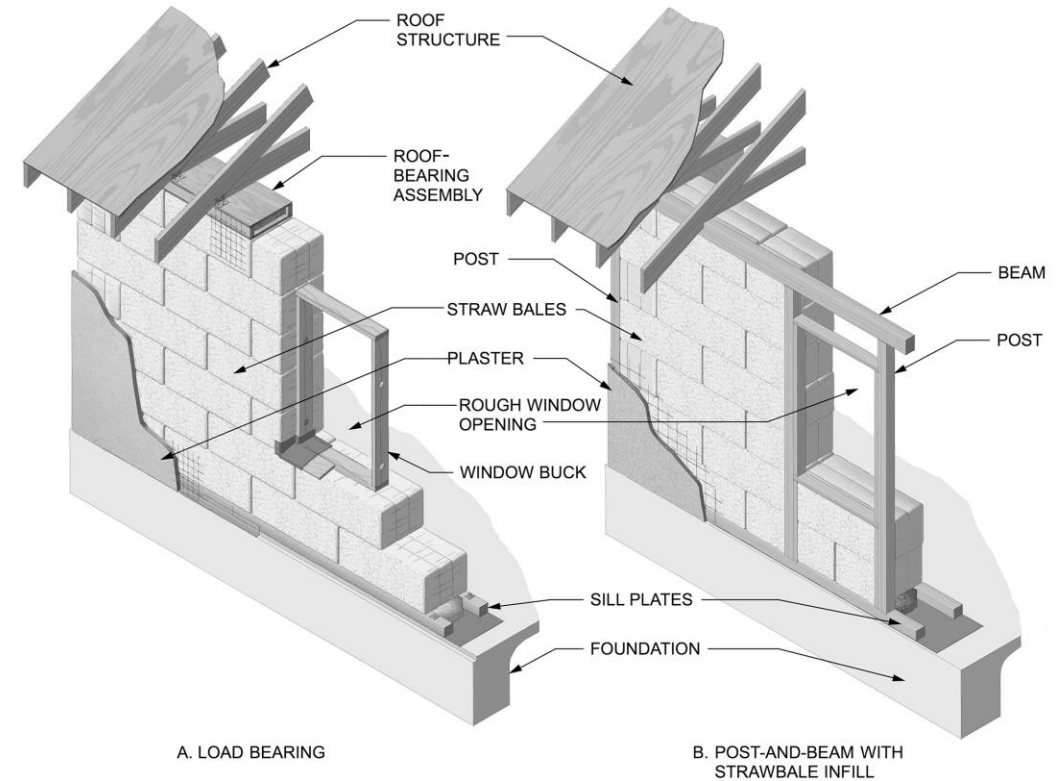


Hemp-lime



Strawbale

- Straw from wheat, rye, oats, rice, or barley used as load-bearing wall or infill in a wood frame.
- **Finished with lime, cement, or clay plaster, creating a fully fire-resistant, non-toxic wall.**
- Dense-packed straw, tied into bales, creates an anaerobic environment and retards flame spread.
- Like heavy timber, chars when burned to minimize further combustion.
- Can be deployed as modular wall panel system.



NOTE: SEE FIGURES AS105.1(1) THROUGH AS105.1(4) FOR DETAILED VIEWS AND SECTION REFERENCES. OTHER STRAWBALE WALL SYSTEMS OR VARIATIONS ARE PERMITTED AS APPROVED.



Strawbale



Light Straw Clay

- Been used in Europe and Asia for thousands of years, US since 1990s.
- Non-load bearing insulation infill material made of loose straw coated with liquid clay (clay slip).
- Packed into forms and finished with non-combustible lime or clay plaster.
- Untested but fire resistance similar to cob and strawbale. Non-toxic, no off-gassing, low flame spread.
- Can be finished in a variety of materials, including wood and metal, provided there is an air gap for moisture control.
- Excellent for new construction or retrofits.



Fire Testing Data

Material	Details	ASTM E119	ASTM E84
Monolithic Adobe	10" thick wall Unfinished	2-HR rated (2021)*	
Hempcrete	12" thick wall 1" lime plaster EF	1-HR Rated (2024)	<u>Class A (2020)</u> FSI = 0 SDI = 0
Strawbale	15" x 18" x 36" bales 1" cement plaster EF	2-HR rated (2006)	<u>Class A (2000)</u> FSI- 10 SDI - 350
Light Straw Clay		2-HR** (untested)	

*Tri-density wall. For 45 to 90 pcf.

**Light Straw Clay has yet to be fully tested but would likely have similar performance to cob.



Hempcrete ASTM E119 Fire Test – Intertek Facility in York, PA (2024)



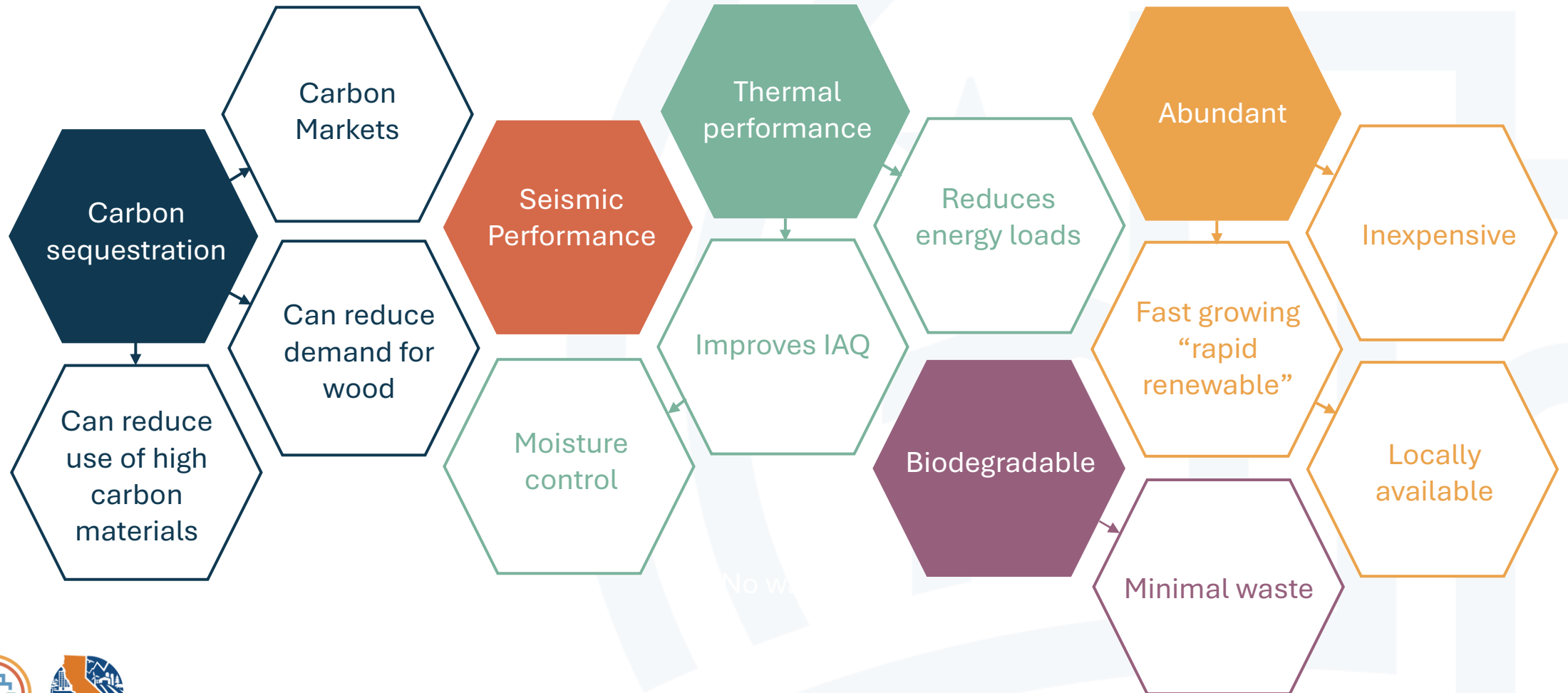
Fire Testing Data

Monolithic Adobe
ASTM E119 Test –
ICC testing facility
in Bryan, TX (2021)
Source: Art Ludwig
@ Oasis Design



Multi-Benefits

These materials also have multi-benefits that go well beyond fire resilience.



Code & Precedent: CA & US

Material	IRC Adoption	CRC Adoption
Monolithic Adobe	2021 Appendix U 2024 Appendix BK	2025 - TBD
Hempcrete	2024 Appendix BL	2025 - TBD
Strawbale	2015 Appendix S 2024 Appendix BJ	2019 Appendix AS* 2025 Appendix AS*
Light Straw Clay	2015 Appendix R 2024 Appendix BI	2025 - TBD

*adopted for mandatory state-wide use



Approved Standard for Earthen IRC Structures

TITLE 14 HOUSING AND CONSTRUCTION
CHAPTER 7 BUILDING CODES GENERAL
PART 4 2021 NEW MEXICO EARTHEN BUILDING

14.7.4.1 ISSUING AGENCY: Construction Industries D and Licensing Department.
[14.7.4.1 NMAC - Rp, 14.7.4.1 NMAC, 11/15/2016]

14.7.4.2 SCOPE: This rule applies to all earthen building performed in New Mexico on or after November 15, 2016, that is su CID, unless performed pursuant to a permit for which an applicator before that date.
[14.7.4.2 NMAC - Rp, 14.7.4.2 NMAC, 11/15/2016]

14.7.4.3 STATUTORY AUTHORITY: Section 60-13-9 [14.7.4.3 NMAC - Rp, 14.7.4.3 NMAC, 11/15/2016]

14.7.4.4 DURATION: Permanent.
[14.7.4.4 NMAC - Rp, 14.7.4.4 NMAC, 11/15/2016]

14.7.4.5 EFFECTIVE DATE: November 15, 2016, unle end of a section. From the date of publication of this rule in the Nev December 14, 2023, permits may be issued under either the previou rule. After December 14, 2023, permits may be issued only under tl [14.7.4.5 NMAC - Rp, 14.7.4.5 NMAC, 11/15/2016; A, 07/14/2023]

14.7.4.6 OBJECTIVE: The purpose of this rule is to est for earthen building materials construction in New Mexico.
[14.7.4.6 NMAC - Rp, 14.7.4.6 NMAC, 11/15/2016]

14.7.4.7 DEFINITIONS:
A. **Amended soil** means improving an unqualified the addition of other soils or amendments.
B. **Amendments** means additive elements to soil, cement, fly ash, etc. which are "dry-mixed" into the main soil body weight to achieve stabilization.
C. **Buttress** means a projecting structure providing The buttress shall be incorporated into the foundation and wall syste earthen building figures supplement).
D. **CEB** means compressed earth block.
E. **Count Rumford fireplace** means a fireplace wi opening with coved sides and a shallow firebox depth of at least 12 than one third of the width of the firebox. The fireback is vertical at The throat is located at least two inches above the lintel and is a nozzle, rounded or streamlined so as to preserve laminar flow of the dilution air through the throat and with a cross-sectional area large enough to insure the elimination of all products of combustion.
F. **Keyway** means a groove on the vertical rammed earth wall surface for

Earthen Wall Structures

Section R614.1 General. Earthen wall structures in Seismic Design Category A, B or C with basic wind speed of 90 mph or less with wind exposure category of A, B, or C may be designed and constructed in accordance with the provisions of this Standard.

This Section shall comply with the seismic requirements of the *International Residential Code*. Exception: Structures with any site conditions may be designed with accepted engineering practice for earthen wall structures and the provisions of the approved Standard for IBC Earthen Structures.

Section R614.1.1 Earthen materials. This section shall establish minimum standards for safety for construction of earthen materials structures, collectively known as adobe, rammed earth, and hydraulic pressed unit construction.

Section R614.1.2 Professional registration not required. When the empirical design provisions of this standard are used to design wall systems, project drawings, typical details and specifications are not required to bear the seal of an architect or engineer.

Section R614.1.3 Professional registration required. When the earthen structure exceeds the empirical design provisions of this standard, the plans and specifications shall be prepared by an Arizona Registrant. All such projects shall be designed in accordance with the approved Standard for IBC Earthen Structures.

Section R614.2 Dimensions of earth walls. Dimensions of earthen walls shall conform to the requirements of this section.

Section R614.2.1 Thickness and Height. The minimum thickness and maximum height of earthen walls and parapets shall be in accordance with Tables R614.2.1 (1 to 6) based upon the Sds value for the project site. Wall thickness shall be measured from face to face of walls with concave joints. Walls with rake joints shall be measured surface of joint to surface of joint. The thickness of wall sections shall not be combined without full cross bonding of the masonry units throughout the wall.

Exception: Walls supported only at ground level and only supported at the base of the wall shall be limited to a height of ½ that allowed by Tables R614.2.1 (1 to 6).

Standard for Earthen Residential Structures (updated 11/27/2012) Page 1 of 14

Pima County, AZ Earthen Building Code (2012)

New Mexico Earthen Building Code (1991)

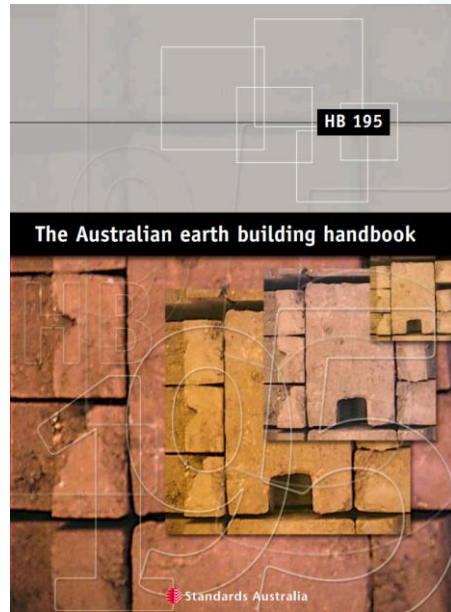


Code & Precedent: Global

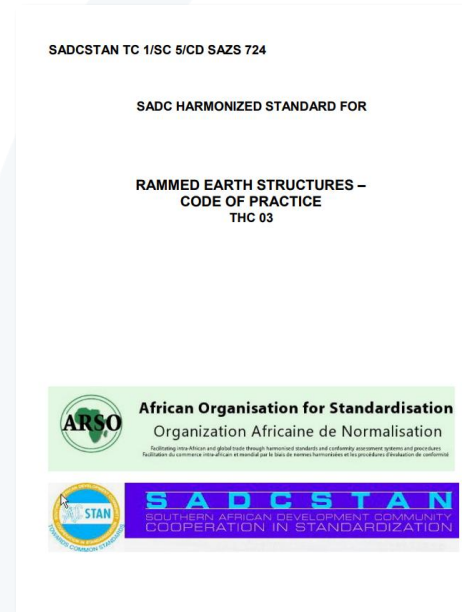
Earthen building codes have been in place in other parts of the world for decades, building on millennia of practical knowledge.



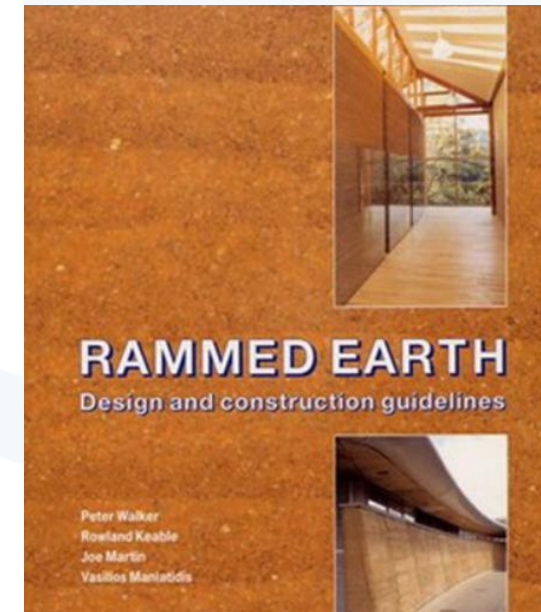
*New Zealand Earthen
Building Code: NZS 4298
(1998)*



*Australian Earthen Building
Code: HB 195 (2002)*



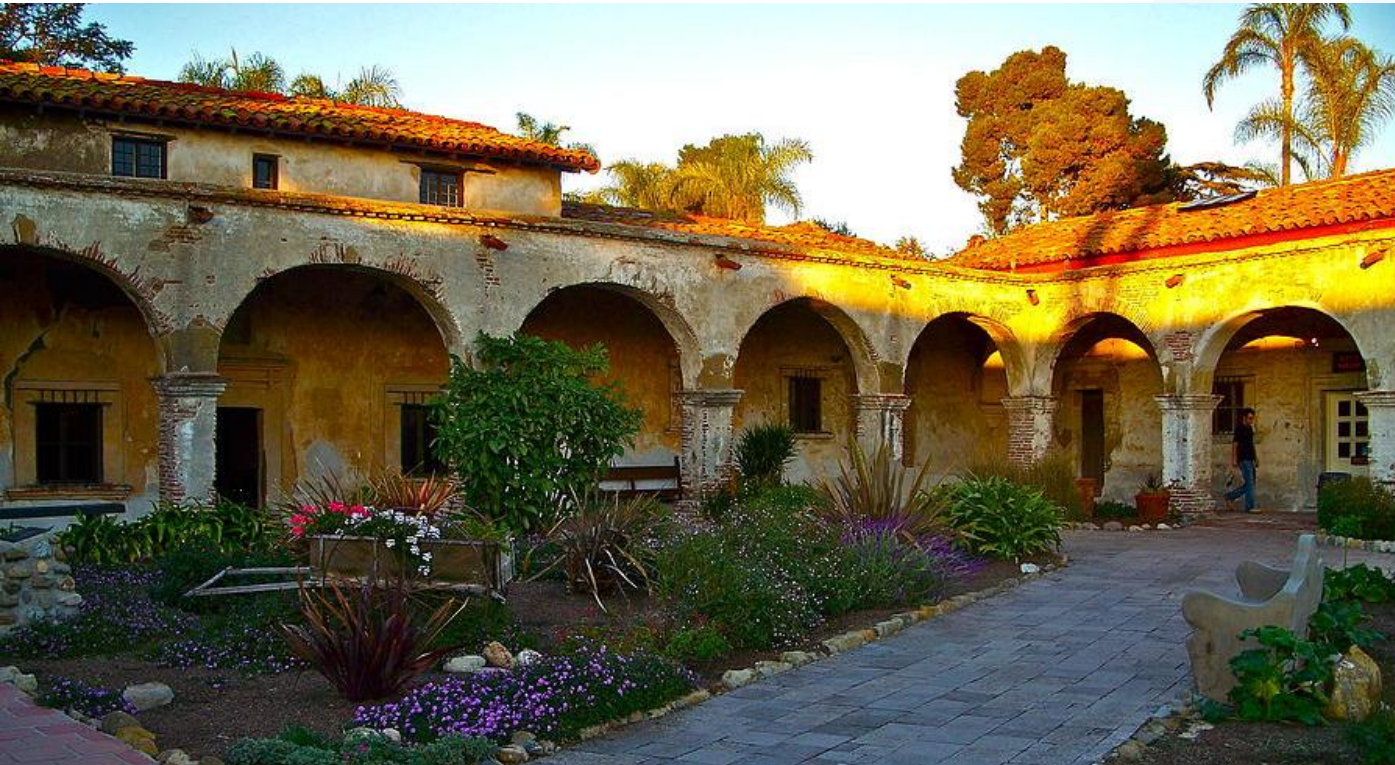
*Zimbabwe Earthen Building
Code: SADC ZW HS 983
(2014)*



*UK Rammed Earth
Construction Guidelines
(2004)*



CA History of Earthen Building



Serra Chapel, Mission San Juan Capistrano. Built 1776. Oldest adobe (brick) structure in CA.



Mission Carmel Church in Carmel, CA

Earthen Building Can Be This:



But Also This:



A rammed earth house in Arizona

Case Studies



Public Safety Complex in Dublin, CA: police and fire department headquarters featuring strawbale walls



Case Studies



A multi-family hempcrete housing project in UK

Case Studies



A cob house in New Zealand

Case Studies



LILAC - A modular strawbale affordable co-housing permaculture community in the UK. Combined stores 1,080 tons CO₂e



Case Studies



A strawbale modular panel system (Modulina) in Lithuania

Case Studies



A strawbale house in Sonoma

Discussion

- Do you have any prior experience with buildings made of these materials?
- What questions or concerns do you have about their viability as a fire safety strategy?
- Are there additional tests that you would like to see conducted?
- What potential do you see for them to be adopted into current model codes through the normal processes?
- What opportunities or obstacles do you foresee with their inclusion as a listed 'product' in the WUI Handbook?



Thank you

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