

The Dirt on Earthen Masonry



Codes, Challenges and Opportunities

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K. Ben Loescher, AIA
Principal, Loescher Meachem Architects

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Introduction:

Why are we talking about an archaic building material?

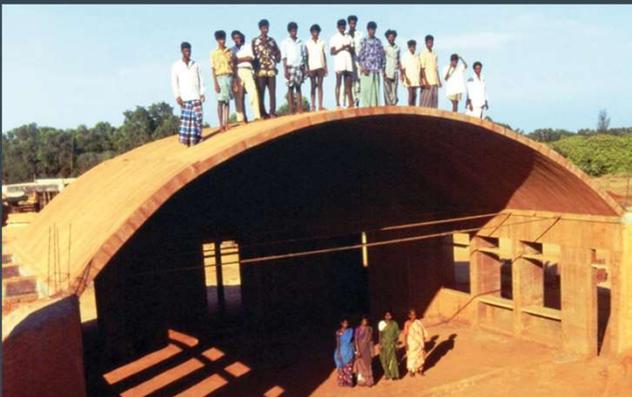


Casa Grande, Arizona. Circa 1350 C.E.

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Deepanam School, Auroville

Introduction:



Deepanam School, Auroville, India (1995)



Waldorf Kindergarten, Sorsum, Germany (1997)

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Types of Earthen Masonry:

- Adobe
 - Wet soil mixture poured or placed into forms and then dried



Two brick adobe form

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 - 8" x 16" x 3 ½" in California and Arizona, 10" x 14" x 3 ½ in New Mexico



Adobe bricks curing, New Mexico Earth, Albuquerque, NM

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 - Compressive strengths for commercially made bricks can range from 300 to 600 psi



New Mexico Earth, Albuquerque, NM

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 - Compressive strengths for commercially made bricks can range from 300 to 600 psi
 - Admixtures for water resistance include asphalt emulsion, portland cement and lime.



New Mexico Earth, Albuquerque, NM

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Types of Earthen Masonry:

Compressed Earth Block (CEB)

- Damp soil mixture mechanically or hydraulically rammed within a chamber



CEB Block Machine, AECT, San Antonio, Texas

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Types of Earthen Masonry:

Compressed Earth Block (CEB)

- Damp soil mixture mechanically or hydraulically rammed within a chamber
- Size varies by manufacturer, but 6" x 12" x 3 1/2" or 10" x 10" x 3 1/2" are typical.



Auram CEB Press, Brick by Brick, Scottsdale, Arizona

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10" x 10" Auram CEB

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Background:

- Most of the historically inhabited areas of the earth have a tradition of earthen construction.



Distribution of earthen construction, after Houben

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- Earthen masonry is a material that transcends cultures



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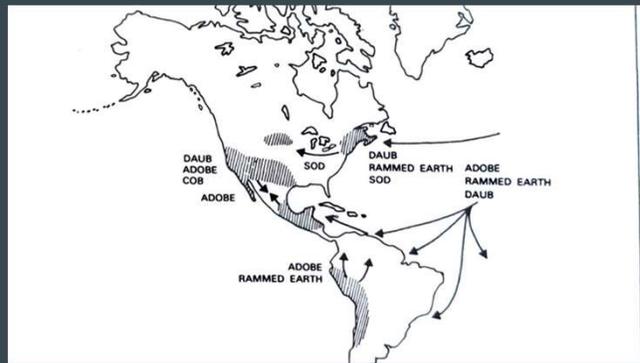
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Distribution of earthen construction, after Houben

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Weir Brothers Construction, Escondido, California

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- 30% of the world's population is estimated to live in homes of unbaked earth



Waldorf School, Weimar, Germany (1999)

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Compressed Earth Block School, Senegal

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Liabilities:

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 - Optimizing soil mixtures can be time consuming but isn't particularly complicated.



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 - Optimizing soil mixtures can be time consuming but isn't particularly complicated.
 - Completed blocks can be graded (like dimensional lumber) for compressive strength, modulus of rupture and water resistance.



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Liabilities:

- Material variability has stymied standardization
- Low strength relative to other masonry products
 - With compressive strengths from 300-1200+ PSI, designs require relatively conservative h/t ratios and wall spans



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- Low strength relative to other masonry products
- Seismic risk when improperly designed or constructed
 - Competent design requires modern foundations and bond beams just like conventional masonry.

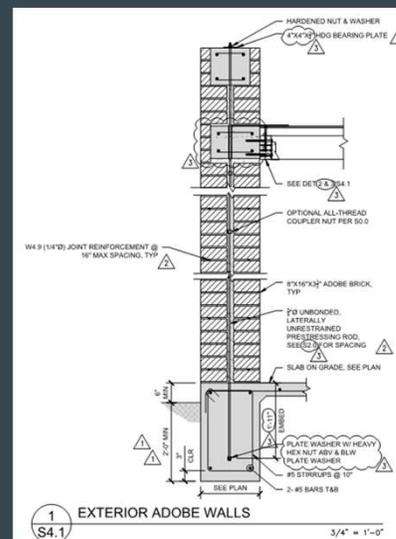


Novikoff residence, Silver City, New Mexico

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 - Competent design requires modern foundations and bond beams just like conventional masonry.
 - Lack of composite action between rebar and earthen materials mean that other reinforcing strategies must be used:
 - Concrete grouted cores
 - Post-tensioning
 - Containment systems
 - Post and Beam restraint



Edlund Residence, Pioneertown, California (Verdant Structural Engineers)

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- Thermal properties optimal only for specific climate zones

Steady State and Effective U/R Values for a
14" Adobe Wall, Albuquerque (4425 HDD)

	Steady State	Wall Orientation			
		North	East	West	South
U	0.203	0.181	0.160	0.165	0.133
R (1/U)	4.926	5.525	6.250	6.061	7.519

State of New Mexico Energy Institute

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- Thermal properties optimal only for specific climate zones
- High transportation costs



New Mexico Earth, Albuquerque, NM

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- Material variability has stymied standardization
- Low strength relative to other masonry products
- Seismic risk when improperly designed or constructed
- Thermal properties optimal only for specific climate zones
- High transportation costs
- Antiquated and often confusing code provisions



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Benefits:

- Material availability

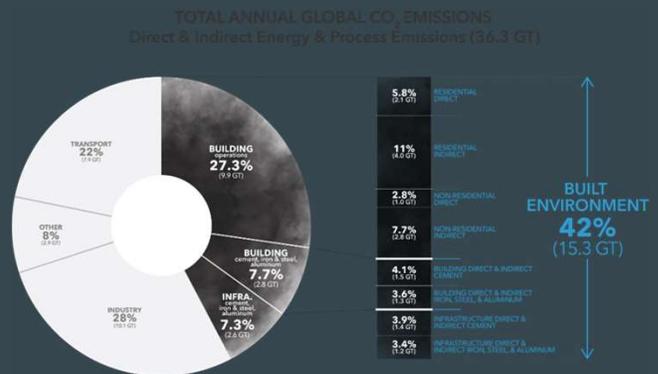


Pauma Valley, California

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Benefits:

- Material availability
- Low-embodied carbon



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Benefits:

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- Thermal performance optimal for specific climate zones



Van Dresser Home, Santa Fe, NM

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Benefits:

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- Thermal performance optimal for specific climate zones
- Extremely high fire-resistance



Quail Springs ASTM 119 Test

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- Thermal performance optimal for specific climate zones
- Extremely high fire-resistance
- Highly recyclable



Earth plastered adobe walls, Fort Union, NM

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- Thermal performance optimal for specific climate zones
- Extremely high fire-resistance
- Highly recyclable
- Very low barriers to entry



Westchester Community Garden, Los Angeles, CA

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Benefits:

- Material availability
- Low-embodied carbon
- Thermal performance optimal for specific climate zones
- Extremely high fire-resistance
- Highly recyclable
- Very low barriers to entry
- Consumer desirability

Adobe Santa Fe Home Built More Than 175 Years Ago Now Offered at \$12.5 Million

Ansel Adams extensively photographed the landmark residence, which captures the "romanticism" of the region's classic style

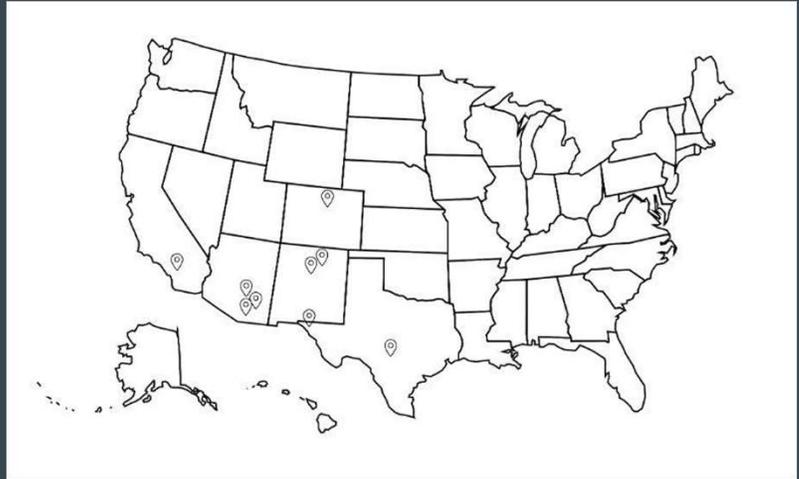
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State of the Industry:

- Ten Commercial Producers throughout the Southwest

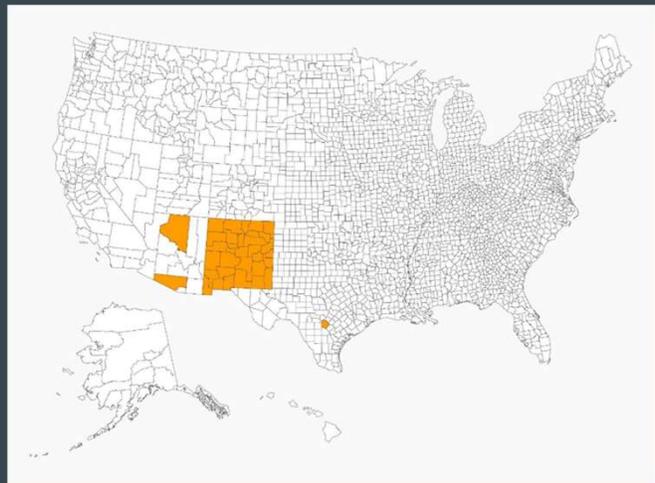


Commercial Earthen Block Manufacturers

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State of the Industry:

- Ten Commercial Producers throughout the Southwest
- Use governed by IBC Section 2109, with some local codes and amendments



Locations with local codes for earthen masonry

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Slide 35

- 1 This map image needs to be replaced with one that includes the content here: <https://docs.google.com/spreadsheets/d/1b61RpMa48iBOGzbdL3cBQkV9tSpXyGyES>
Ben Loescher, 11/3/2023

Outlook:

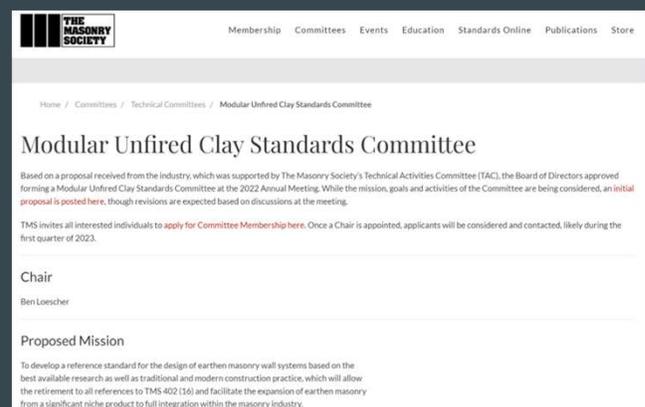
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- Regulatory movement toward requiring carbon accounting may increase desirability

New California law addresses embodied carbon



Image credit: JackF, Adobe Stock

Rebecca Price

3 minute read



Sep 27, 2022

Learn how the new law builds on existing strategy.

On Sept. 16, California governor Gavin Newsom signed [AB 2446](#) into law, adding to the rising number of state policies targeting embodied carbon in buildings.

In the buildings context, **embodied carbon** refers to the greenhouse gas (GHG) emissions generated by the manufacturing, transportation, installation, maintenance and disposal of building materials. Without significant action, embodied carbon is poised to [increase in proportion](#) to total emissions of the building sector.

The [Buy Clean California Act](#), enacted in 2017, was the first statewide policy addressing embodied carbon of some building materials. The act requires contractors who bid on state infrastructure projects to disclose emissions data for certain materials, such as steel and glass.

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- WUI regulation increasingly favors fire-resistant construction

Data shows building codes can reduce vulnerability of homes in wildfires

Bill Gabbert January 30, 2022 Uncategorized California, FireWise, home ignition zone, Oakland Hills Fire, Tunnel Fire



Burned homes in Slave Lake. May 16, 2011. Alberta, Canada. CTV.

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