adobe

The Material
Its Deterioration
Its Coatings

James Garrison
adobe: The Material

A-do-be, n. 1: a brick or building material of sun-dried earth and straw  2: a heavy clay used in making adobe bricks  3: a structure made of adobe bricks.
adobe: The Material
adobe: The Material
# adobe: The Material

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
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<tbody>
<tr>
<td><strong>CLAY</strong></td>
<td>15%</td>
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<tr>
<td><strong>SILT</strong></td>
<td>10-30%</td>
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<tr>
<td><strong>SAND</strong></td>
<td>55-75%</td>
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![Image of adobe mixture](image-url)
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USDA Textural Classification Chart
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Sieve Analysis - Grain Size Distribution
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adobe: The Material
adobe: The Material
adobe: The Material
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- Clay Minerals: Hydrous Aluminium Phyllosilicates
- Weathering of Feldspar
- Kaolin Group
- Smectite Group
- Illite Group
- Chlorite Group
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The molecular structure of adhesive clay consists of 2 silicon-centered tetrahedral layers (blue) and one aluminum octahedral layer (purple) forming crystalline sheets.
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- Characteristics of Masonry Materials, Stone, Brick, Block, Adobe
  - Brittle
    - low tensile strength
    - high compressive strength
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BRITTLE

Strain

Stress

Tensile Strength

Compressive Strength
Material Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Adobe</th>
<th>Sandstone</th>
<th>Concrete</th>
<th>Steel</th>
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<tr>
<td>Density (#cf)</td>
<td>95</td>
<td>147</td>
<td>150</td>
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<tr>
<td>Compressive Strength (psi)</td>
<td>50-</td>
<td>120-</td>
<td>625-</td>
<td>2500-</td>
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<tr>
<td></td>
<td>300</td>
<td>1800</td>
<td>2500+</td>
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</tr>
<tr>
<td>Resistance</td>
<td>.23</td>
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<td>Coefficient of Thermal Expansion</td>
<td>3.0x10^-6</td>
<td>4.4</td>
<td>6.5</td>
<td>6.7</td>
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</table>
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- Characteristics of Masonry Materials, Stone, Brick, Block, Adobe
  - Brittle
    - low tensile strength
    - high compressive strength
  - Hydrophilic
    - Water Loving
Hydrophilic vs Hydrophobic

Hydrophilic
- Glass
- Brick
- Stone
- Mortar
- Metal
- Adobe

Hydrophobic
- Hydrocarbons
- Bitumen
- Fats
- Wax
- Silicone
- Polyethylene
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Characteristics of Masonry Materials, Stone, Brick, Block, Adobe

- Brittle
  - low tensile strength
  - high compressive strength

- Hydrophilic
  - Water Loving

- Porous
  - Permeable by water or air
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Atterberg Limits
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\[
\text{WET} - \text{DRY} = \frac{\text{H}_2\text{O}}{} \times 100 = \% \text{H}_2\text{O}
\]

BY WEIGHT
Deterioration

- Stress
  - Extrinsic
  - Intrinsic
Deterioration

- Basal Erosion (Rising Damp)
- Surface Erosion
- Cracks or Bulges
- Coating Failure
- Slump or Creep
- Displacement
- Collapse
Basal Erosion

- Rising Damp
Basal Erosion

- Rising Damp
Basal Erosion

- Rising Damp
Basal Erosion

- Rising Damp
Basal Erosion

- Rising Damp

*Figure 28. Deterioration is a process which has a cause and effect.*
Basal Erosion

- Rising Damp

Figure 34. Capillary Rise
Basal Erosion
Surface Erosion

- Uniform Coverage
- Concentrated Run-off
Surface Erosion
Surface Erosion

Figure 30. The Wet/Dry Cycle
Surface Erosion

Figure 33. The Freeze/Thaw Cycle
Surface Erosion

Figure 35. Condensation

- Cold dry air/wall core cooled
- Warm moist air meets cold wall/condensation
- Evaporation/soluble salt crystallization
Cracks or Bulges

- Diagonal
- Tension
- Compression
- Shear
Cracks

- Diagonal Cracks
Cracks

Figure 3.2

(a) Ends of building settle relative to the centre; cracks increase in width with height.

(b) Centre of building settles relative to the ends; cracks decrease in width with height.

(c) Ends of building settle relative to the centre, causing diagonal cracks.

(d) Centre of building settles relative to the ends, causing diagonal cracks.
Cracks
Cracks

- Anchors and Steel Angle
- Major Cracks
- Portions of Masonry to be Rebuilt
- Outline of pre-event building - note offset of corner masonry.
- Steel support column at center of north wall at interior.
- Supports center span steel beam
Cracks

- Tension Cracks
Cracks

- Compression Cracks
Cracks
Cracks
Cracks
Cracks
Cracks
Cracks
Cracks

- Shear Cracks
Coating Failure

- Detachment
Coating Failure

- Detachment
Slump or Creep

- Elastic Limit
- Plastic Limit
Displacement

- Center Third Rule
Collapse

- Center Third Rule
Coatings

- Mud Plaster
- Gypsum Plaster
- Lime Plaster
- Cement Plaster
Mud Plaster

- Sand
- Silt
- Clay
Mud Plaster

- Sand
- Silt
- Clay
Mud Plaster

- Sand
- Silt
- Clay
Mud Plaster

- Sand
- Silt
- Clay
Gypsum Plaster

- Calcium Sulfate Dihydrate
  Gypsum
  $2\text{CaSO}_4 \cdot 4\text{H}_2\text{O}$

- Calcium Sulfate Hemihydrate
  Plaster of Paris
  $2\text{CaSO}_4 \cdot \text{H}_2\text{O} + 3\text{H}_2\text{O}$

- Martin’s Cement (1834)
  Keene’s Cement (1838)
  Parian Cement (1846)
Mortar Basics

- MaSoN wOrK
- 1 part binder to 3 parts sand (by volume)
- M 4 • 1 • 15
- S 2 • 1 • 9
- N 1 • 1 • 6
- O 1 • 2 • 9
- K 1 • 4 • 15

- Plaster Basics: 1 part binder to 4 parts sand
Lime Plaster

- Calcium Carbonate
  - CaCO₃
- Calcium Oxide (Quick Lime)
  - CaO
- Calcium Hydroxide (Slaked Lime)
  - Ca(OH)₂
Lime Plaster

Lime Cycle

LIMESTONE = CaCO₃
Calcium Carbonate

Burnt in kiln at a minimum of 880°C

CaO = QUICKLIME
Calcium Oxide

CO₂ driven off

Exposure to air - “carbonation
CO₂ taken from atmosphere

Ca(OH)₂
Calcium Hydroxide
=
SLAKED LIME

Slaked lime may be used in three forms:
Lime Putty
“Coarse Stuff” (putty: sand mix)
Hydrated Lime (putty dried, ground and powdered)
## Lime Plaster

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<th>1500 BC Egyptian</th>
<th>46 BC Vitruvius</th>
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<th>800 AD Rochester Cathedral</th>
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# Lime Plaster

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Gauging Lime Plaster

- A non-hydraulic lime can be made to set much more rapidly by the addition of an hydraulic or ‘pozzolanic’ additive.
- Crushed brick powder
- Pozzolana
- Trass
- Portland Cement
Lime Plaster
Lime Plaster
Lime Plaster
Lime Plaster
Lime Plaster
Cement Plaster

- Portland Cement
Cement Plaster

- Portland Cement/ Chicken Wire
Cement Plaster

- Portland Cement/ Chicken Wire
Cement Plaster
Cement Plaster
Conclusion

- Know the Material
- Know the Causes of Deterioration
- Know the Coating
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