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The Material Its Deterioration Its Coatings

**James Garrison** 

 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.















#### **USDA Textural Classification Chart**





#### **Sieve Analysis - Grain Size Distribution**









- Clay Minerals: Hydrous Aluminium Phyllosilicates Weathering of Feldspar
- Kaolin Group
- Smectite Group
- Illite Group
- Chlorite Group



The molecular structure of smectite clays consists of 2 silicon-centered tetrahedral layers (blue) and one aluminum octahedral layer (purple) form crystalline sheets.



 Characteristics of Masonry Materials, Stone, Brick, Block, Adobe

- Brittle
  - low tensile strength
  - high compressive strength



# Material Properties

	2038 ×	SAMOS	ofter contraction	ALL STREET	
Density (#cf)	95	147	150		
Compressive Strength (psi)	50- 300	120- 1800	625- 2500-	F	
Resistance	.23	.08	.08		
Coefficient of Thermal Expansion	<b>3.0</b> x10-6	4.4	6.5	6.7	

 Characteristics of Masonry Materials, Stone, Brick, Block, Adobe

– Brittle

- low tensile strength
- high compressive strength
- Hydrophilic
  - Water Loving

### Hydrophilic vs Hydrophobic



 Characteristics of Masonry Materials, Stone, Brick, Block, Adobe

– Brittle

- low tensile strength
- high compressive strength
- Hydrophilic
  - Water Loving
- Porous
  - Permeable by water or air



#### **Atterberg Limits**



### Deterioration

• Stress – Extrinsic



#### – Intrinsic



### Deterioration

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









### • Rising Damp



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





Uniform CoverageConcentrated Run-off











### **Cracks or Bulges**

Diagonal
Tension
Compression
Shear




#### Diagonal Cracks





















#### Compression Cracks

































#### • Shear Cracks



## **Coating Failure**

#### Detachment



## **Coating Failure**

#### • Detachment



## **Slump or Creep**

Elastic LimitPlastic Limit



# Displacement

#### • Center Third Rule



# Collapse

#### • Center Third Rule





• Gypsum Plaster

• Lime Plaster

Cement Plaster









### **Gypsum** Plaster

Calcium Sulfate Dihydrate **Gypsum**  $2CaSO_4 \bullet 4H_2O$  Calcium Sulfate Hemihydrate **Plaster of Paris**  $2CaSO_4 \cdot H_2O + 3H_2O$ • 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

Calcium Carbonate

CaCO<sub>3</sub>

Calcium Oxide (Quick Lime)

CaO

Calcium Hydroxide (Slaked Lime)

Ca(OH)<sub>2</sub>



#### Lime Cycle

.

	Egyptian Vitruvius' time Plinv		Pliny	Rochester Cathedral	Middle Ages		Plat Neve, Moxon		00s	Vicat, Smith Burnell & periodicals		
	150 BC	46 BC	23 AD	800 AD	1200	1500	1653	1703	γ1−bim	1837	1850	
albumen animal glue barley	X X		х					Х	x		Х	
beer					Х	Х			X			
beeswax	v	v	v	v	Х	Х	37	Х	X		Х	
blood butter	X	X	X	X		X	Χ.	X	Х	v	X	
buttermilk									Х	Л		
casein	Х											
cheese								Х	Х	Х	X	
curdled milk		Х							X	Х	Х	
eggs	Х				Х	Х		Х	X		х	
egg whites	Х	Х			Х	Х	Х	Х		Х	Х	
elm bark			Х									

fibers			Х								
fig juice	Х	Х	Х					Х			1
fruit juices				Х	Х			Х			
gluten				Х	Х			Х			
gum arabic	Х				Х	Х				Х	
hair			Х								
hogs' lard		Х	Х				Х			Х	
keratin	Х										1
malt				Х	Х					-	
milk		Х	Х				Х	Х	Х	Х	
molasses									Х		
oil			Х						Х	Х	
resin							Х				
rice				Х	Х						
rye dough		Х						Х			
saiiron			Х								
snellac	1.1		v	v	3.0					X	
size			X V	A	X						
Suet			Λ	v	v				v		
tannin			v	л	Λ				Λ		
urine			Λ	v	v						
vegetable juice				Λ	A			Y			
wine			Y					Λ			
wort			A	x				x			
				A				A		-	

### **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



Portland Cement



#### Portland Cement/ Chicken Wire



#### Portland Cement/ Chicken Wire









#### Conclusion

Know the Material
Know the Causes of Deterioration
Know the Coating



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