Freeze-Thaw Damage

Freezing Temperatures
Water
Susceptible Brick
Susceptible Brick
Firing Temperature
Vitrification
Calculating capillary rise

\[ h = \frac{2 \sigma \cos \theta}{g \rho r} \]

Capillary rise versus diameter

\[ \text{capillary rise [inch]} \]

\[ \text{diameter [inch]} \]
Figure 1a. Gypsum, hydrated from plaster of paris and water, porosity 30 per cent.

Figure 1b. Brick, sintered clay, porosity 40 per cent.
2nd Law of Thermodynamics
Capillarity + Salt = Osmosis

- Mineral salts carried in solution by capillary water
- When water evaporates from a surface the salts left behind form crystals in process called efflorescence
- When water evaporated beneath a surface the salts crystallize within the pore structure of the material in called sub-efflorescence
- The salt crystallization causes expansive forces that can exceed the cohesive strength of the material leading to spalling
Diffusion + Capillarity + Osmosis = Problem

- Diffusion Vapor Pressure 3 to 5 psi
- Capillary Pressure 300 to 500 psi
- Osmosis Pressure 3,000 to 5,000 psi
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Liquid applied membrane waterproofing
Flanged window
Trim closure
Concrete sill
2x6 wood buck
Exterior wythe (repointed or coated with polymer cement slurry)
Multi-wythe masonry wall
Air seal
1½ rigid insulation
Plywood spacer
1x2 backdam
2" spray applied foam insulation (closed-cell, high-density)
Uninsulated steel stud assembly
Gypsum board
Perapet cap flashing sloping to interior with drip edges

Parapet flashing

Slope

Drip

Plaster “filler” for slope supporting flashing
Sloping to interior cap flashing with drip edges

Stainless steel flashing

Reglet