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# Building Science

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Historical Perspective

[www.buildingscience.com](http://www.buildingscience.com)

This evolution thing.....

R2



R2



R4



R2



R4



R6



R2



R4



R6



R8



R2



R4



R6



R8



R8



R2



R4



R6



R8



R8



R1.5





R2



R4



R6



R8



R8



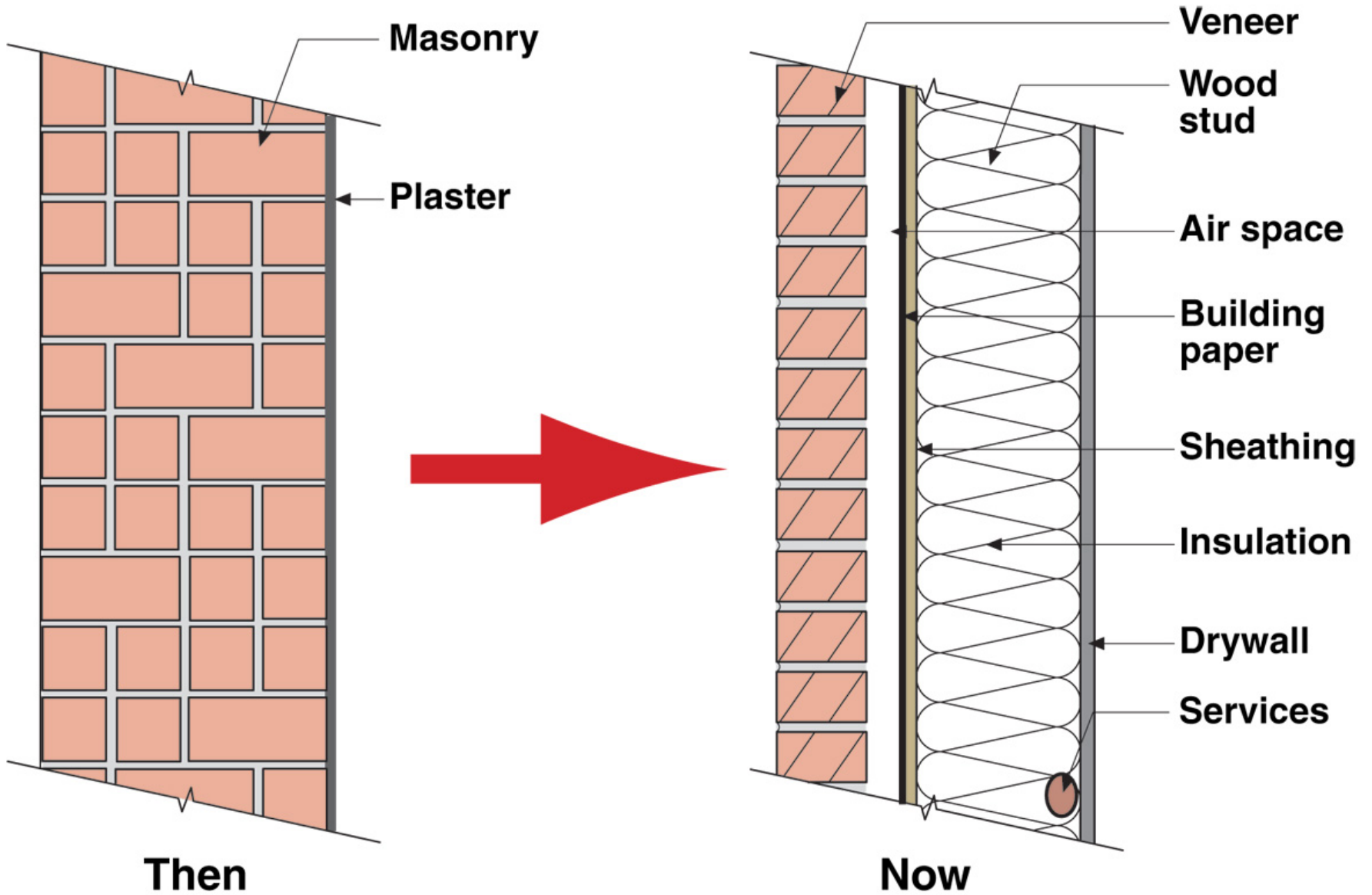
R1.5



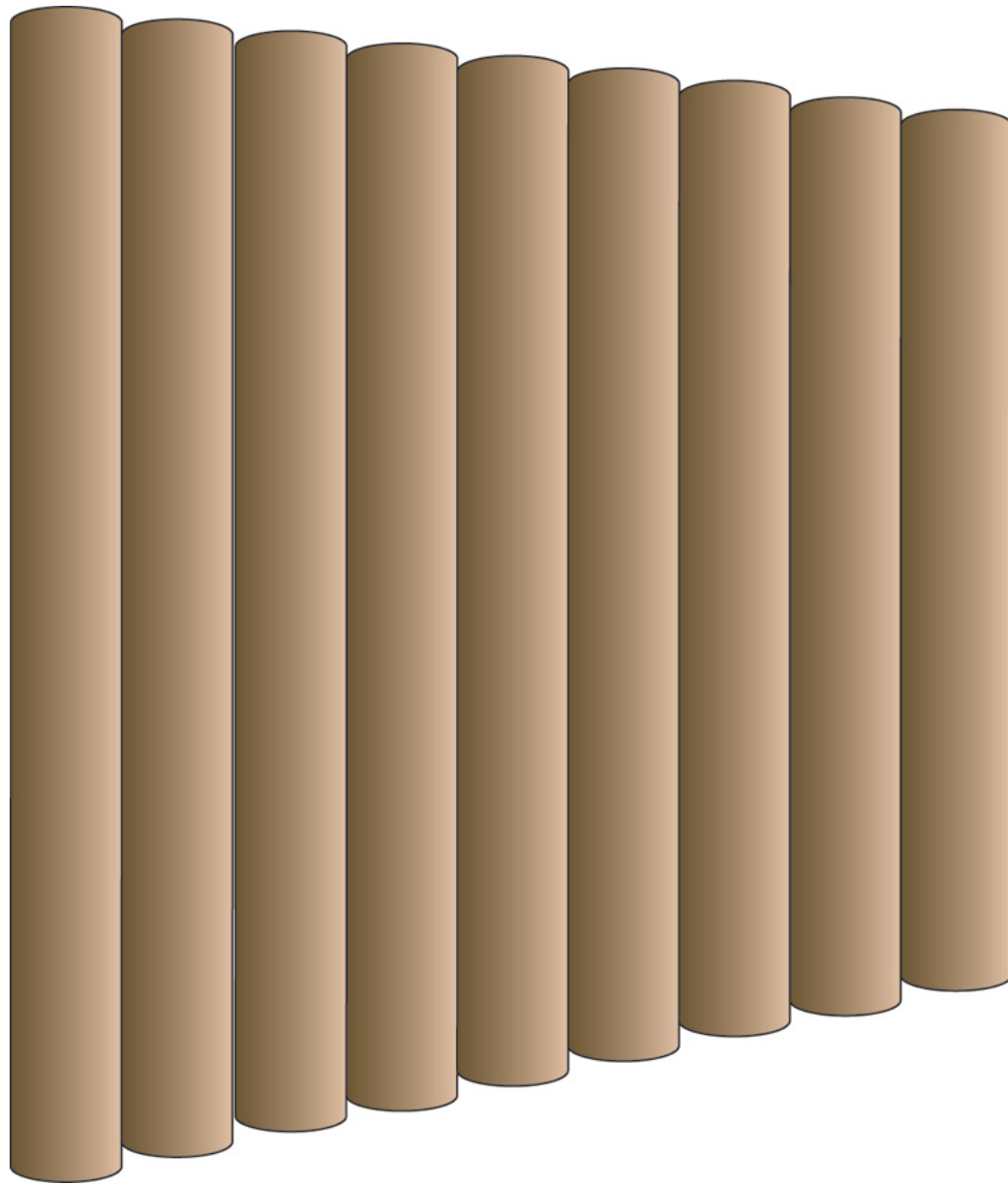
R2



Increased Thermal Resistance  
Permeability of Enclosure Linings  
Water And Mold Sensitivity of Materials  
Hygric Buffer Capacity And Redistribution  
Three Dimensional Air Flow Networks



Another take.....



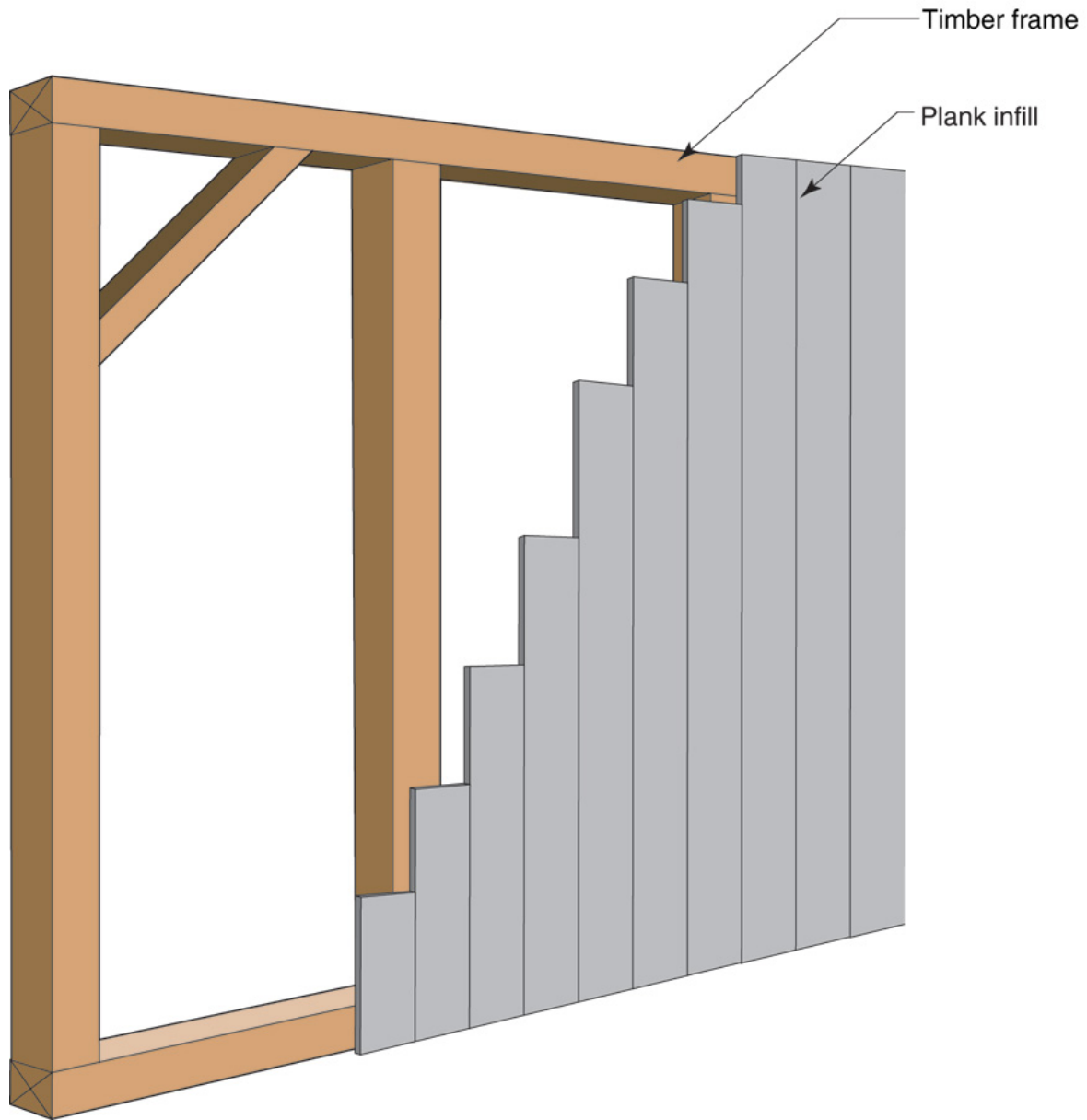




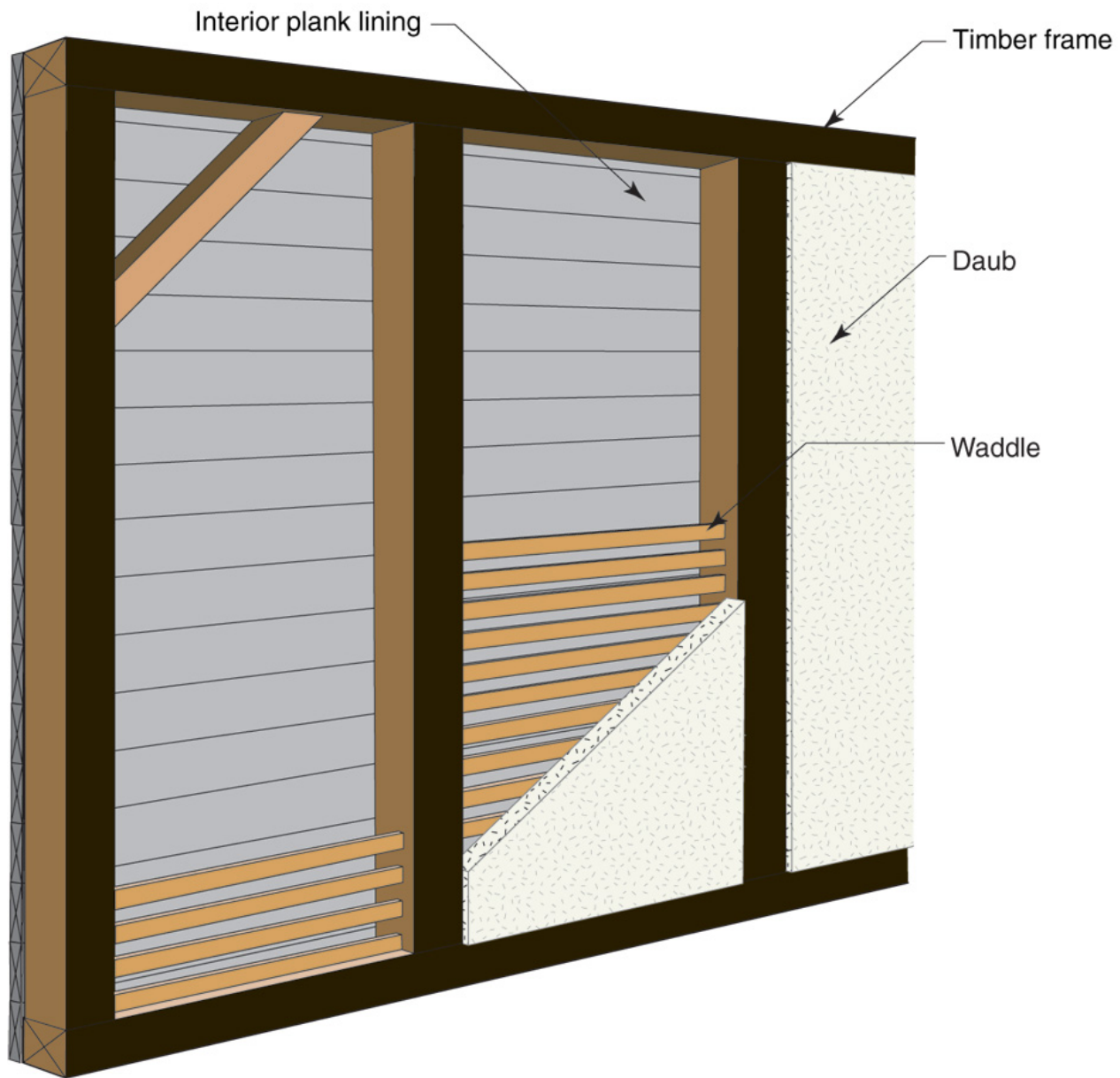












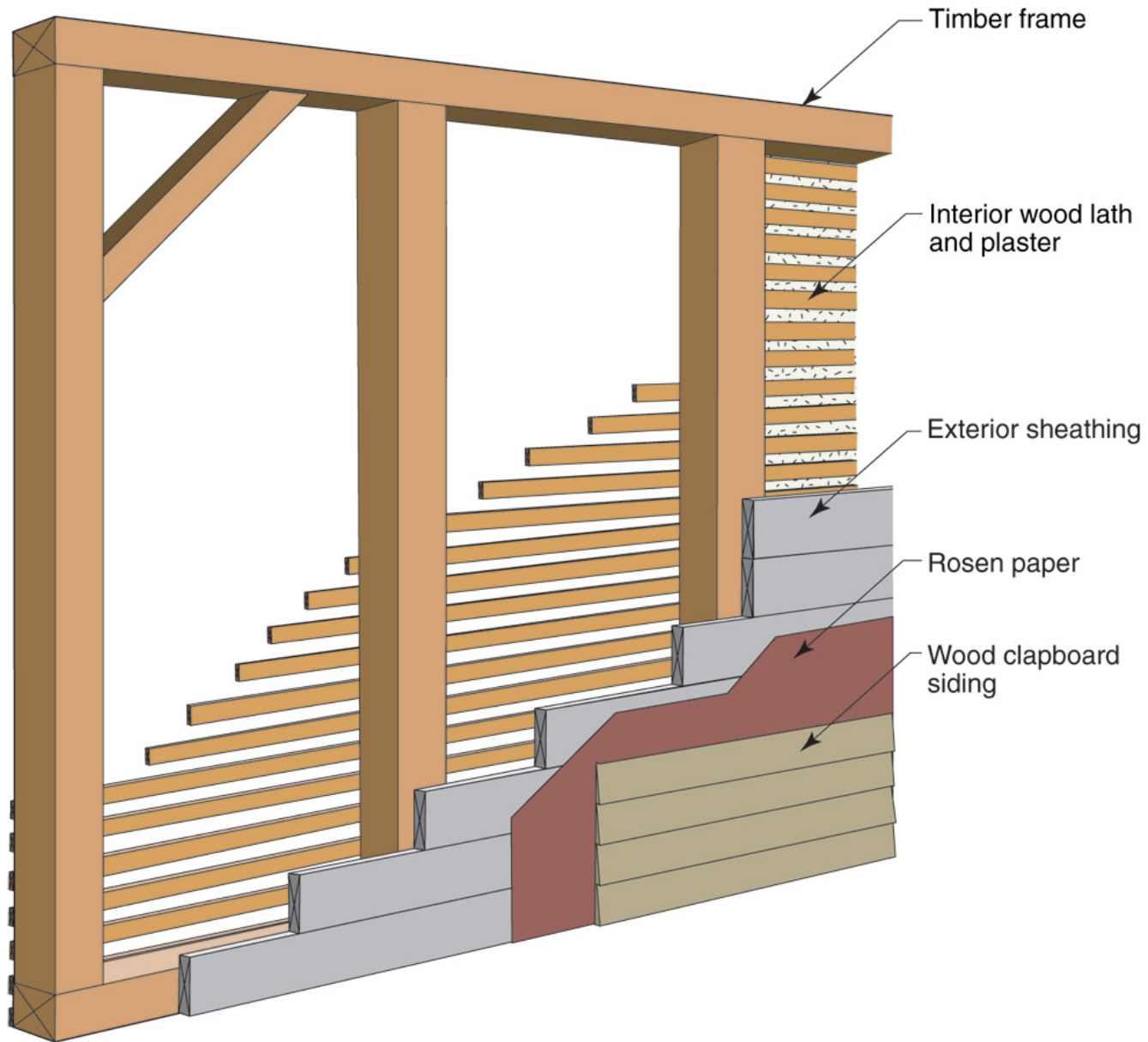






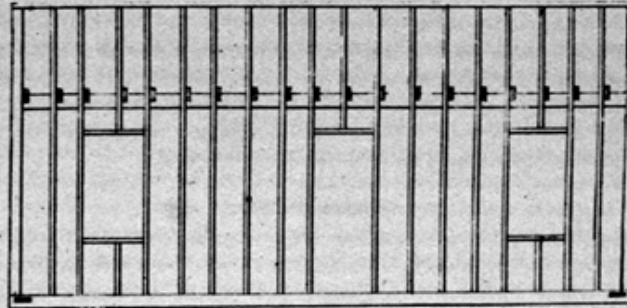




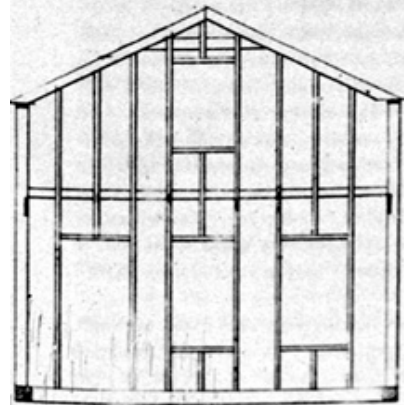


# Plate 5.

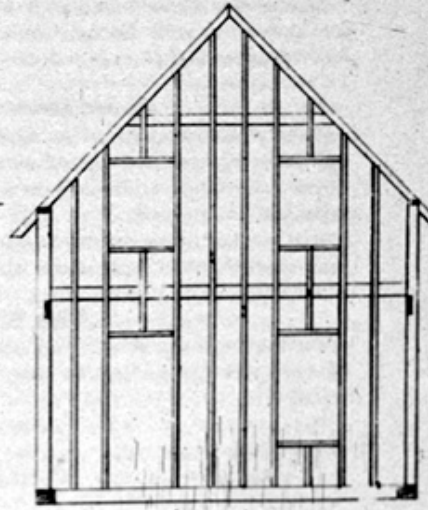
*Fig. 1.*



*Fig. 2.*

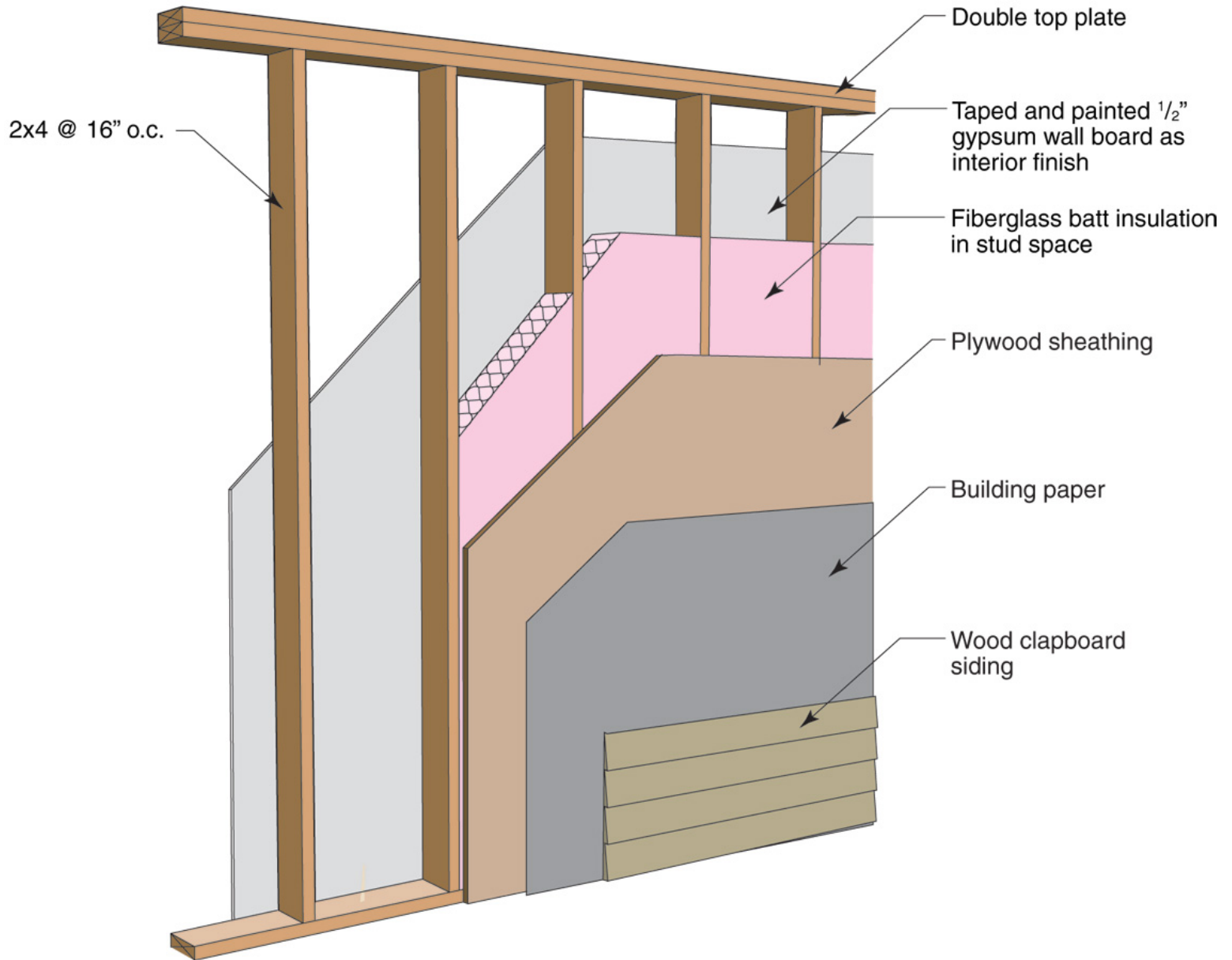


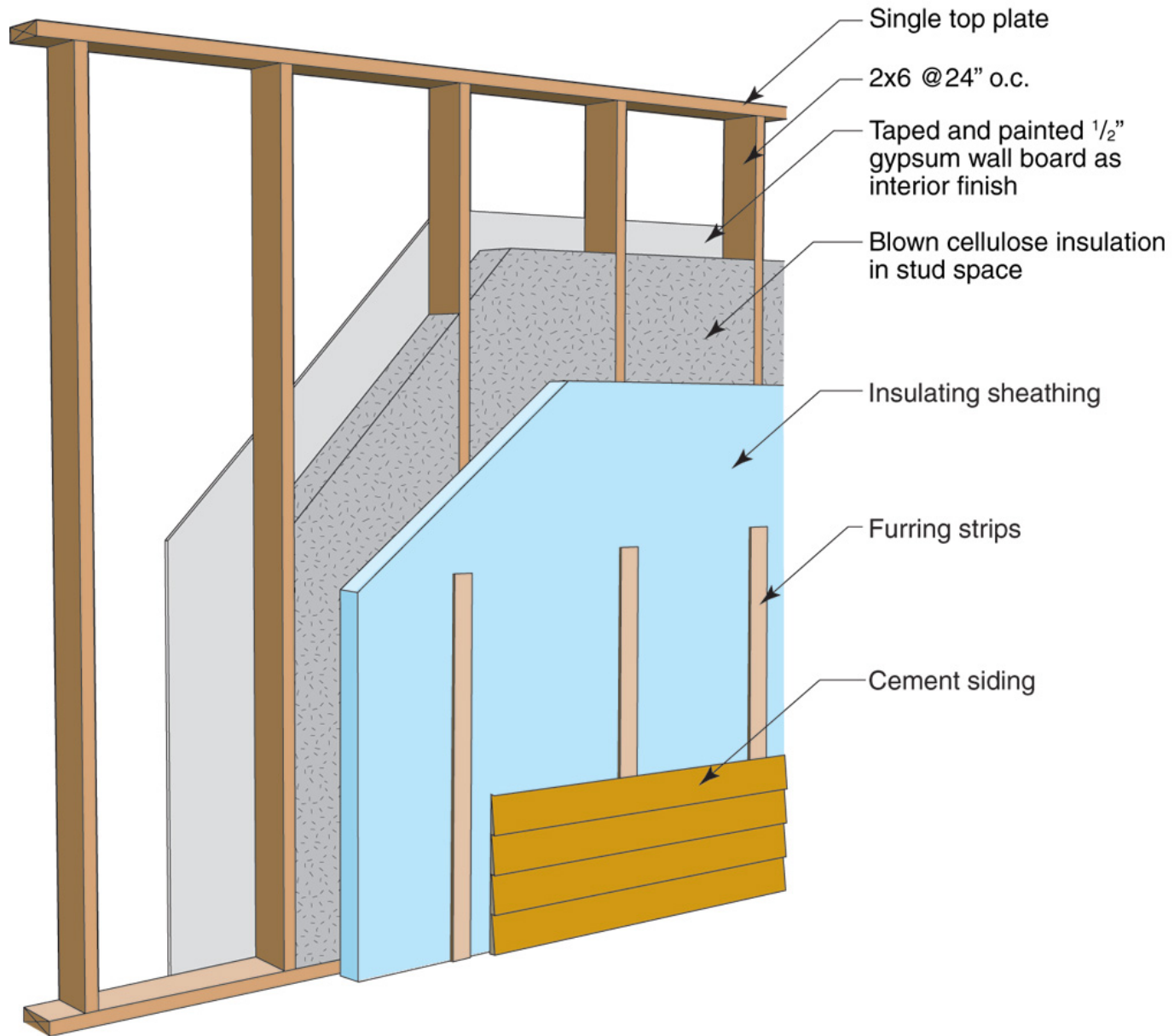
*Fig. 3.*

























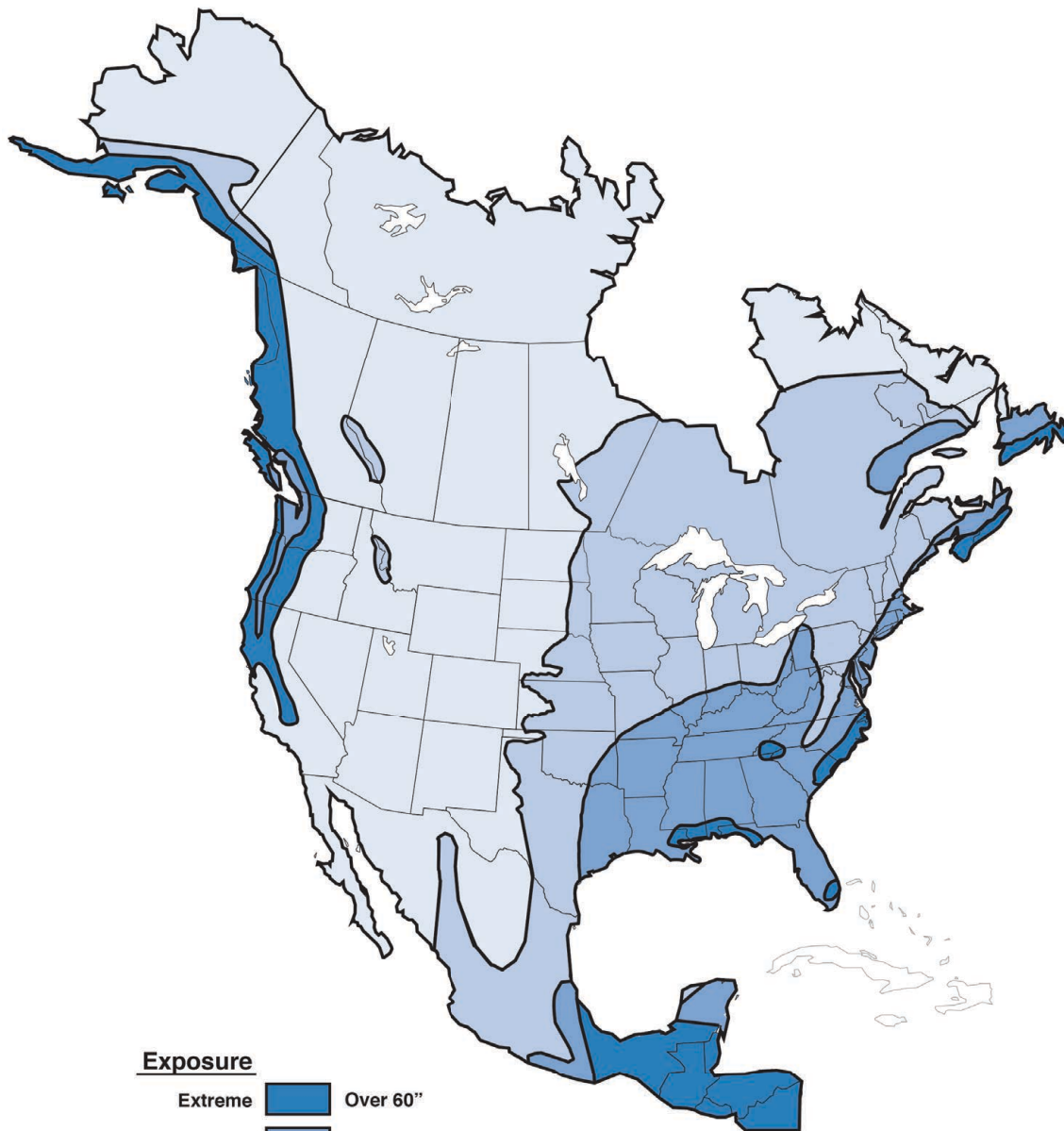


# Freeze-Thaw Damage

Freeze-Thaw Damage  
Freezing Temperatures  
Water  
Susceptible Brick

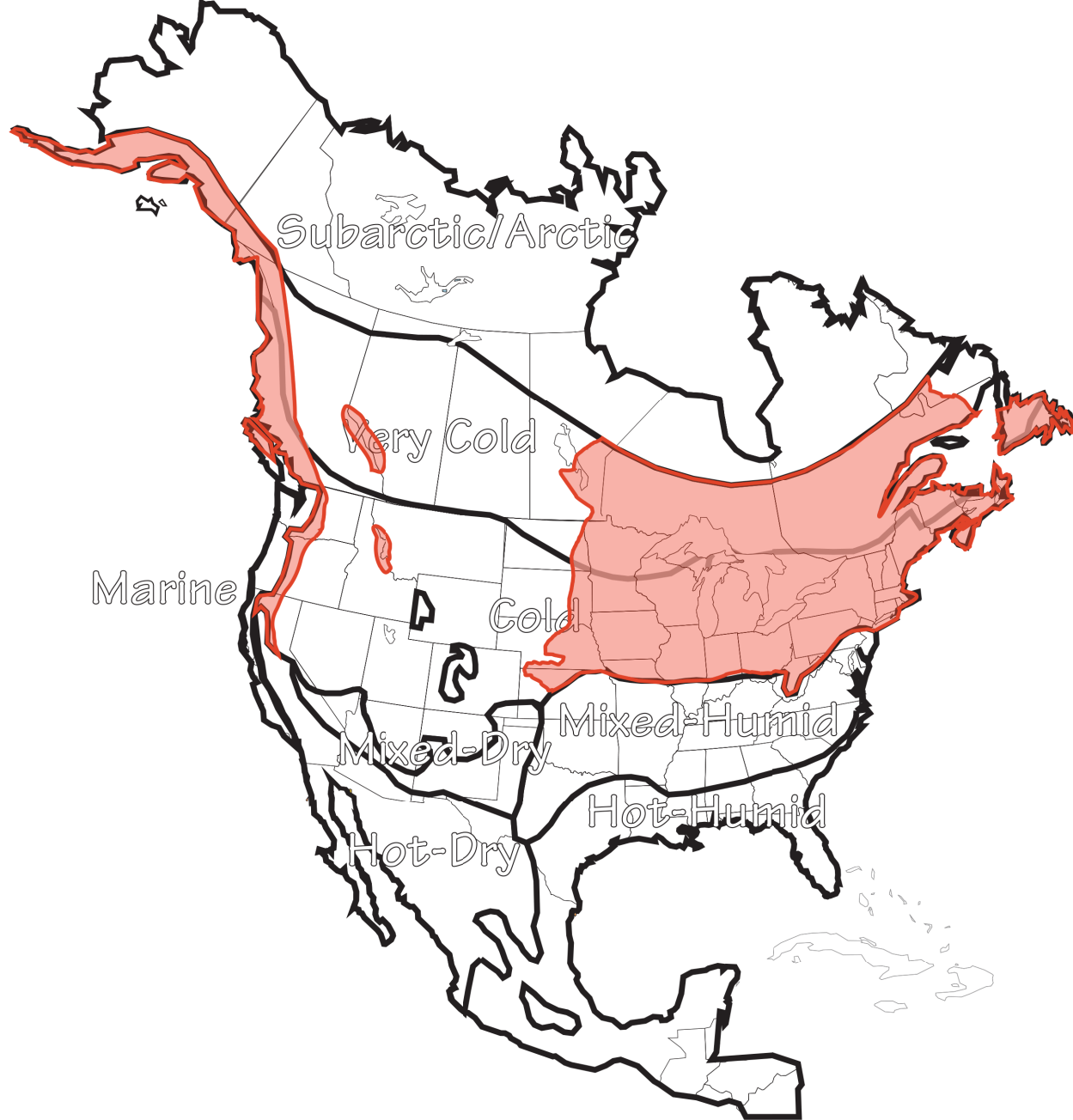




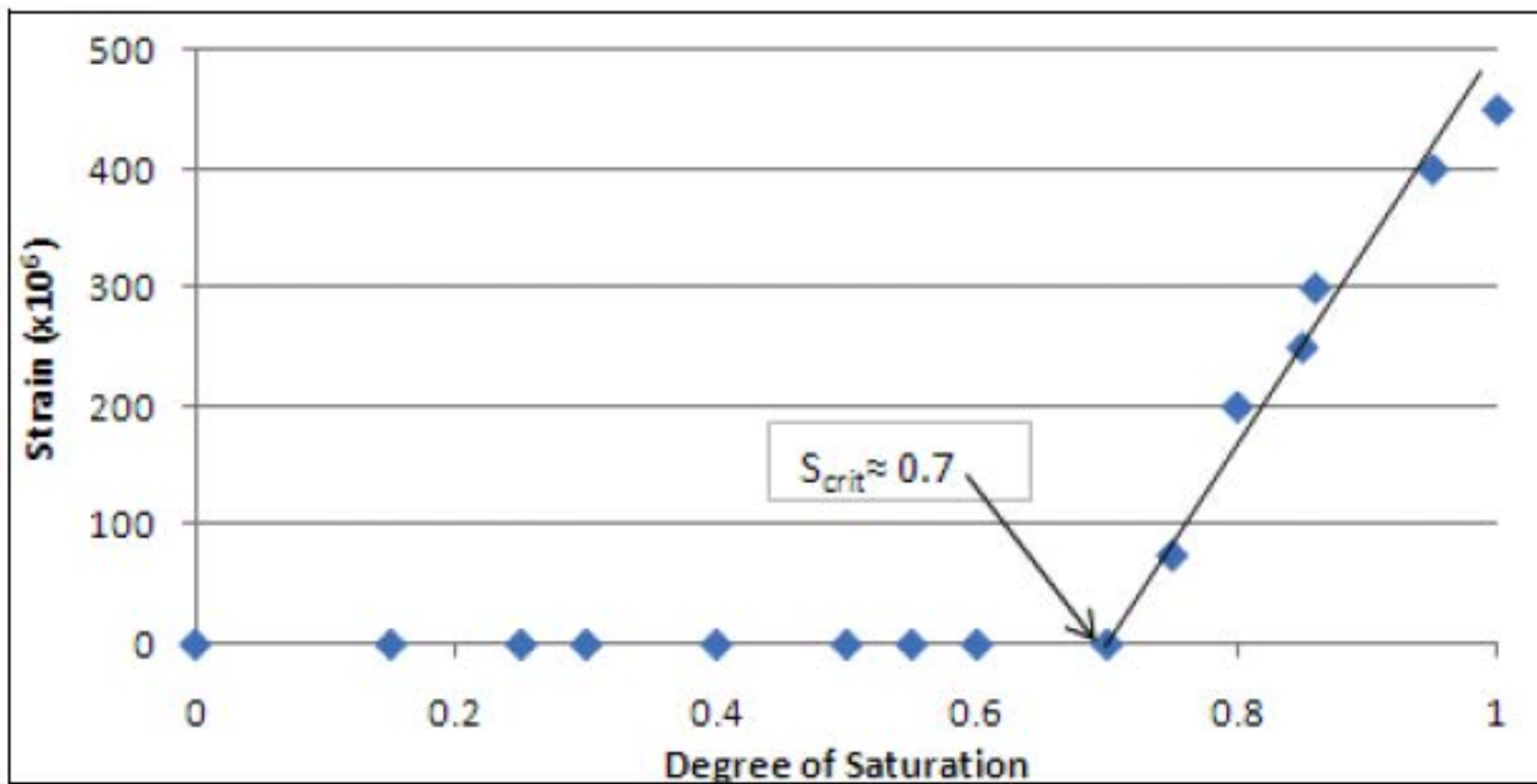


**Exposure**

- Extreme Over 60"
- High 40" - 60"
- Moderate 20" - 40"
- Low Under 20"

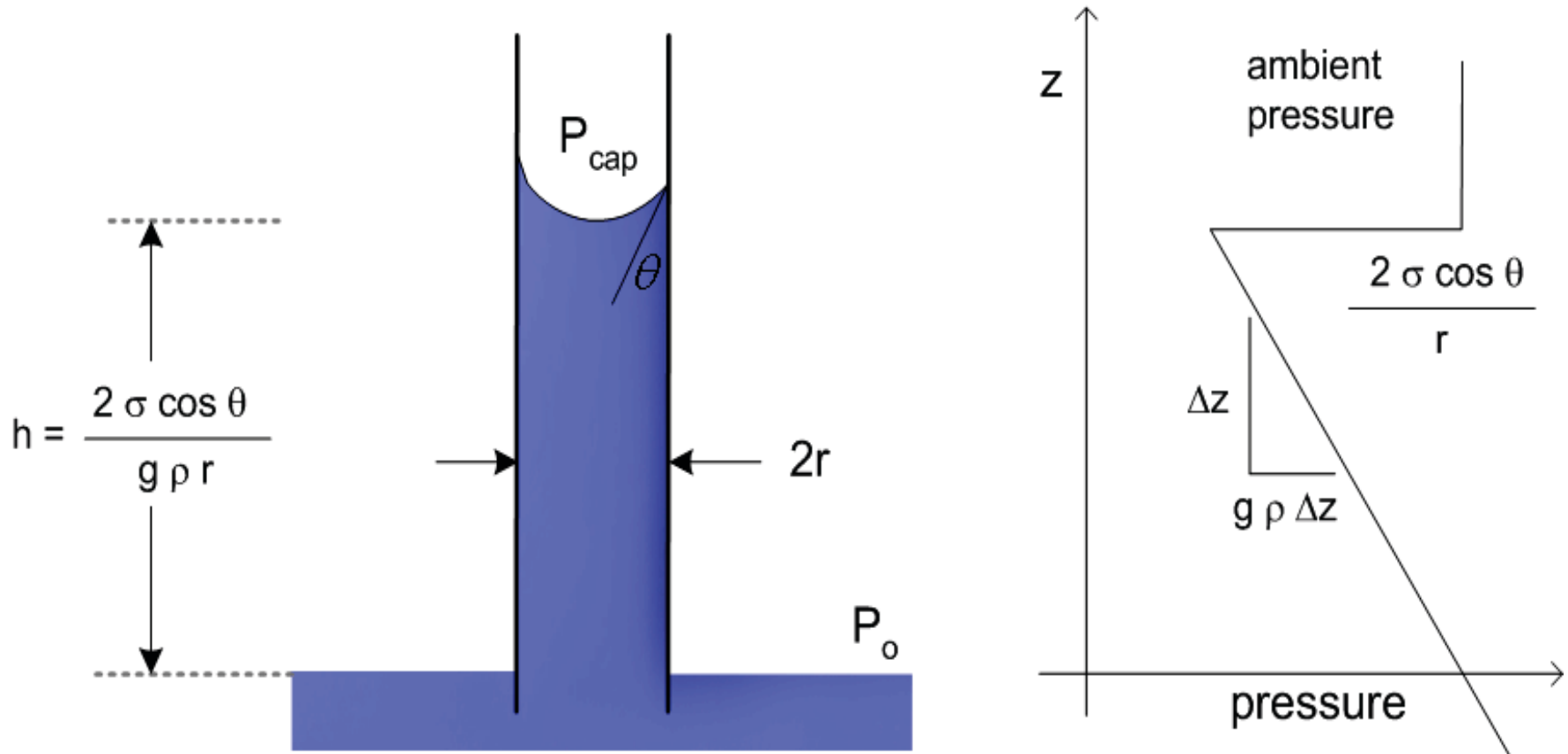


# Susceptible Brick Firing Temperature Vitrification

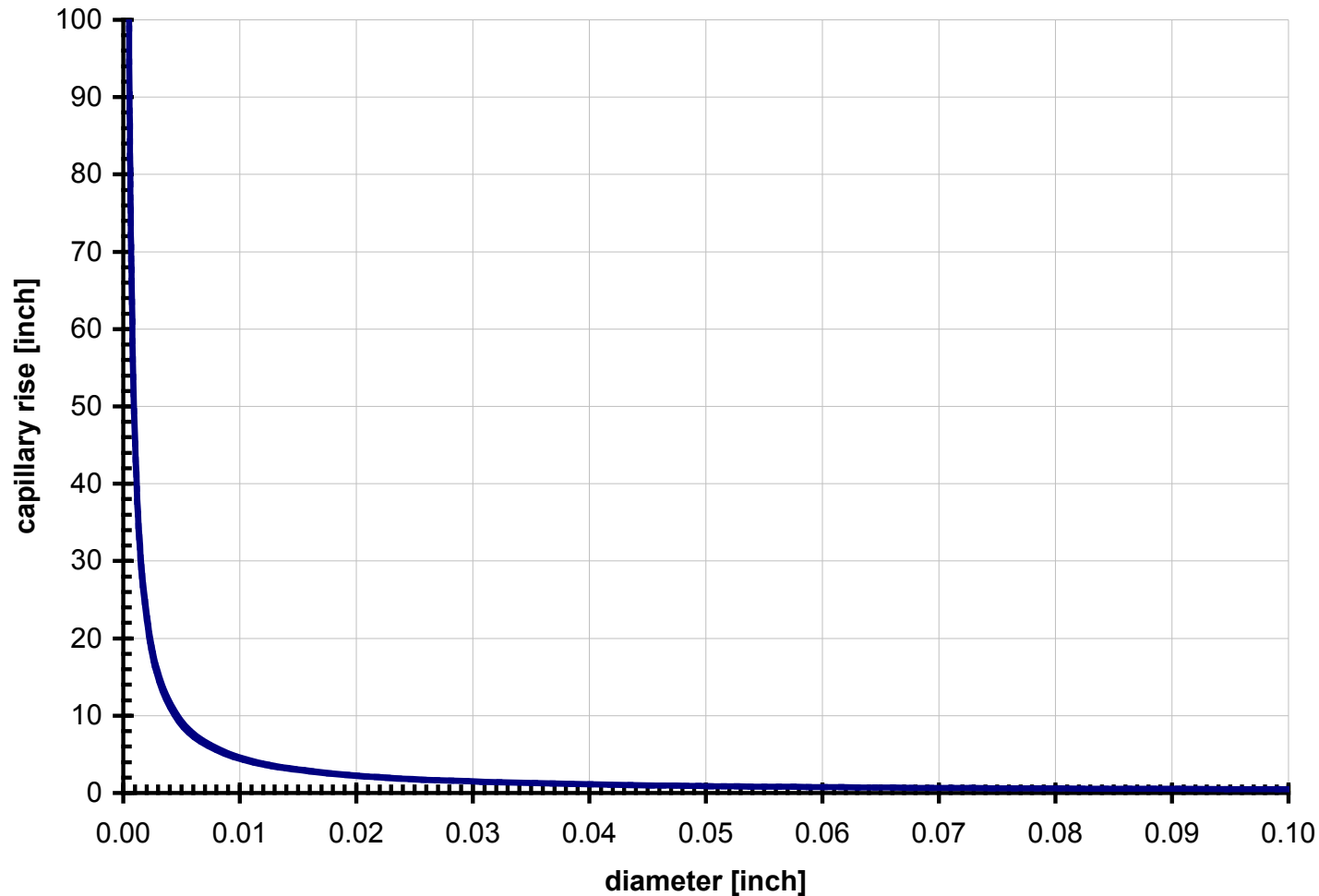


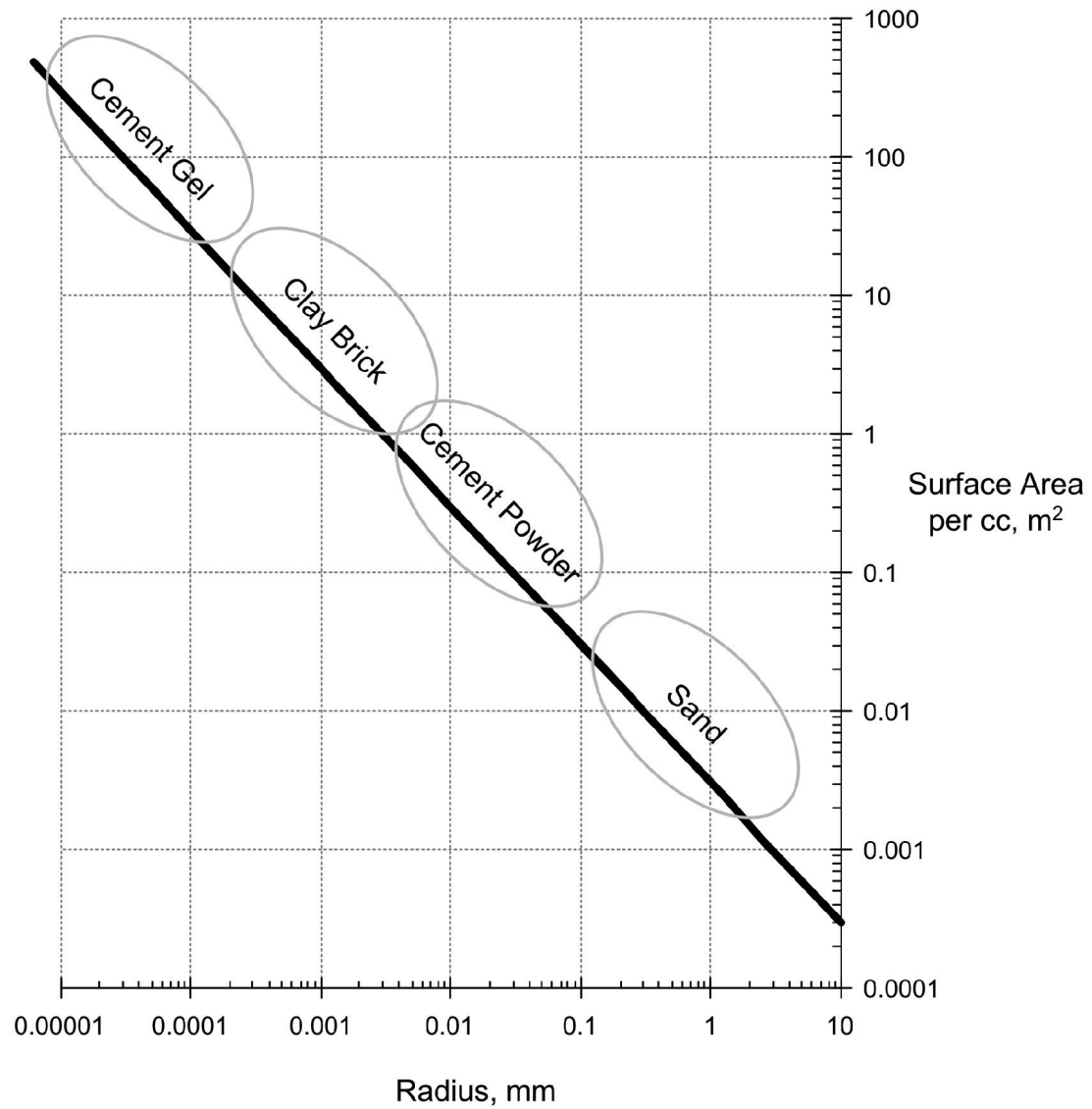


# Calculating capillary rise



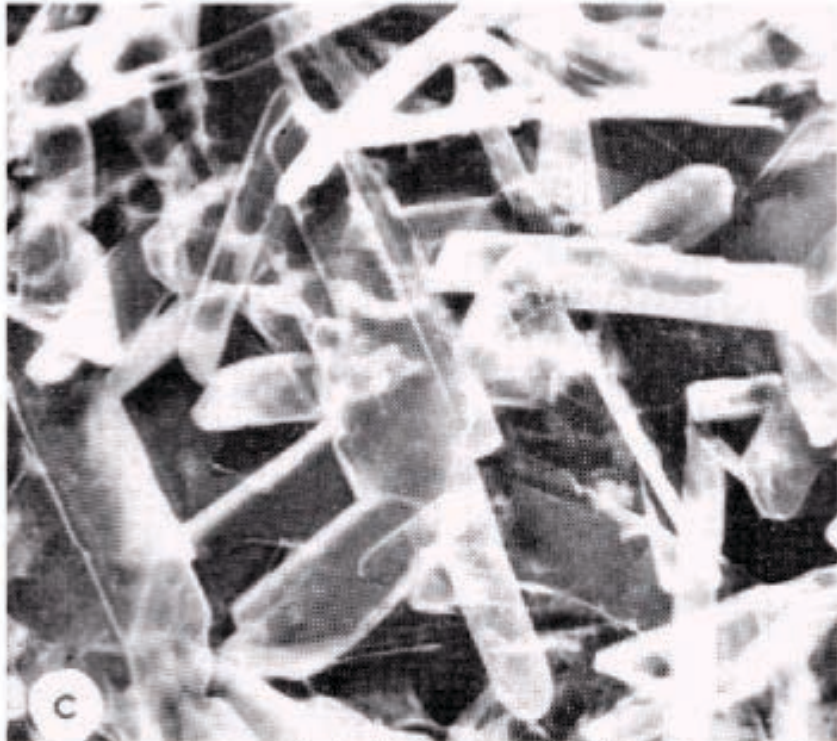
# Capillary rise versus diameter



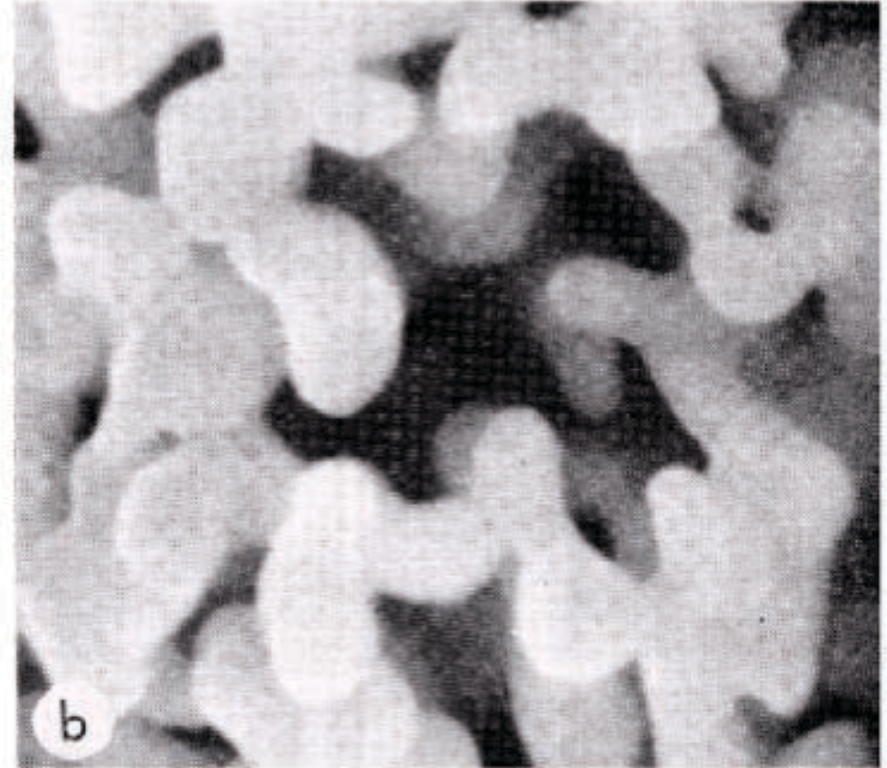


**Surface area vs. particle size**  
 From Straube & Burnett, 2005

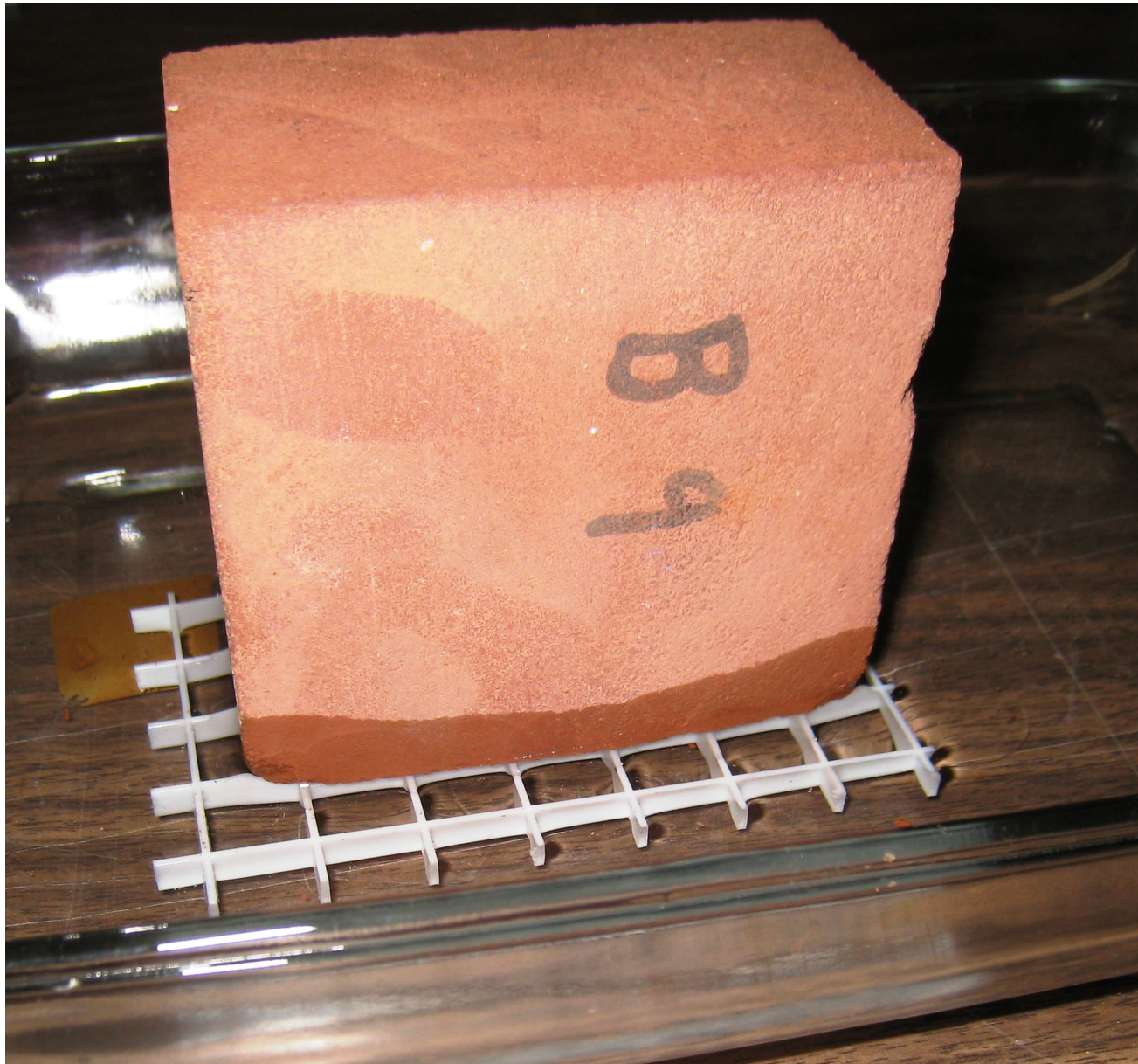


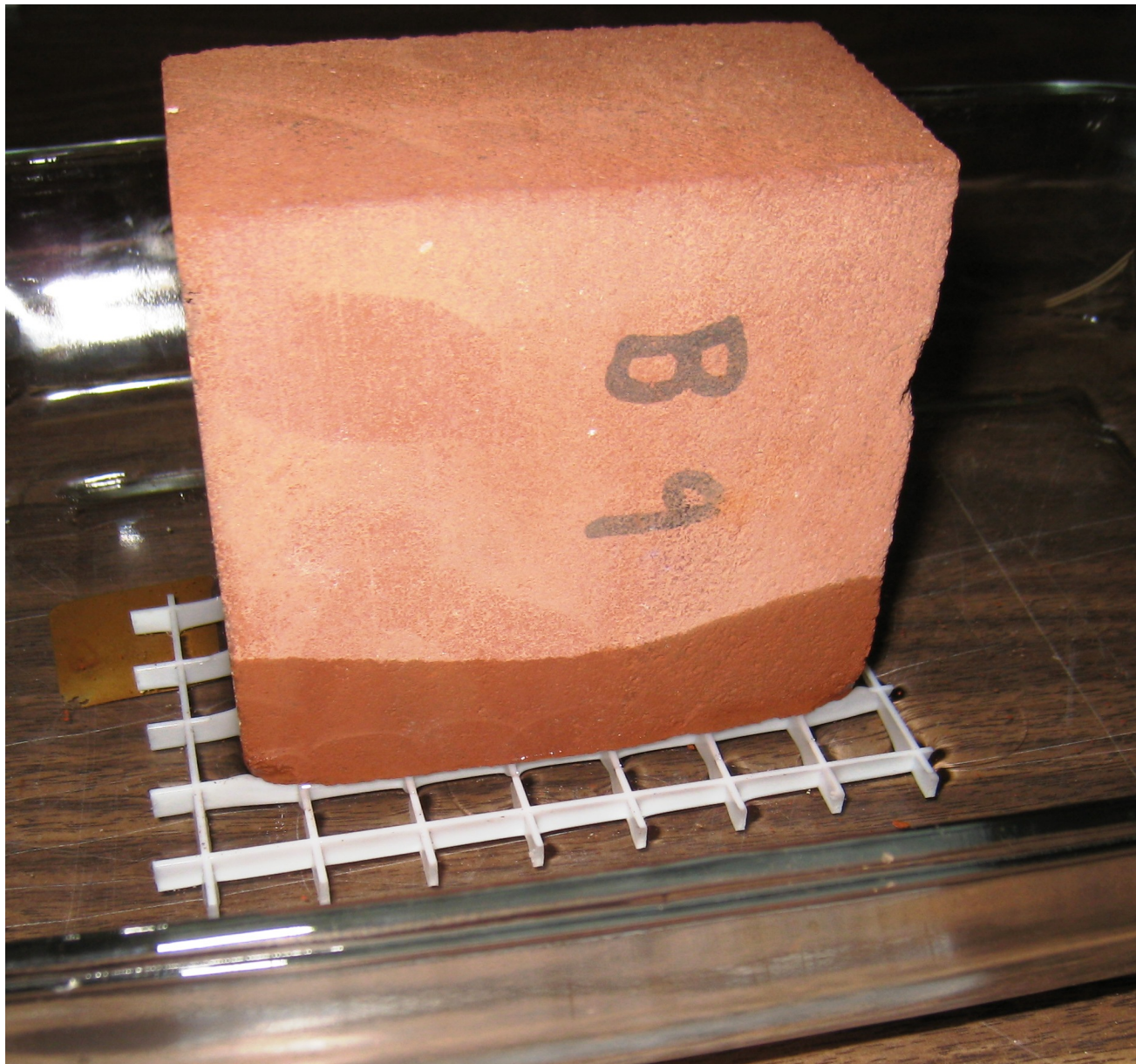


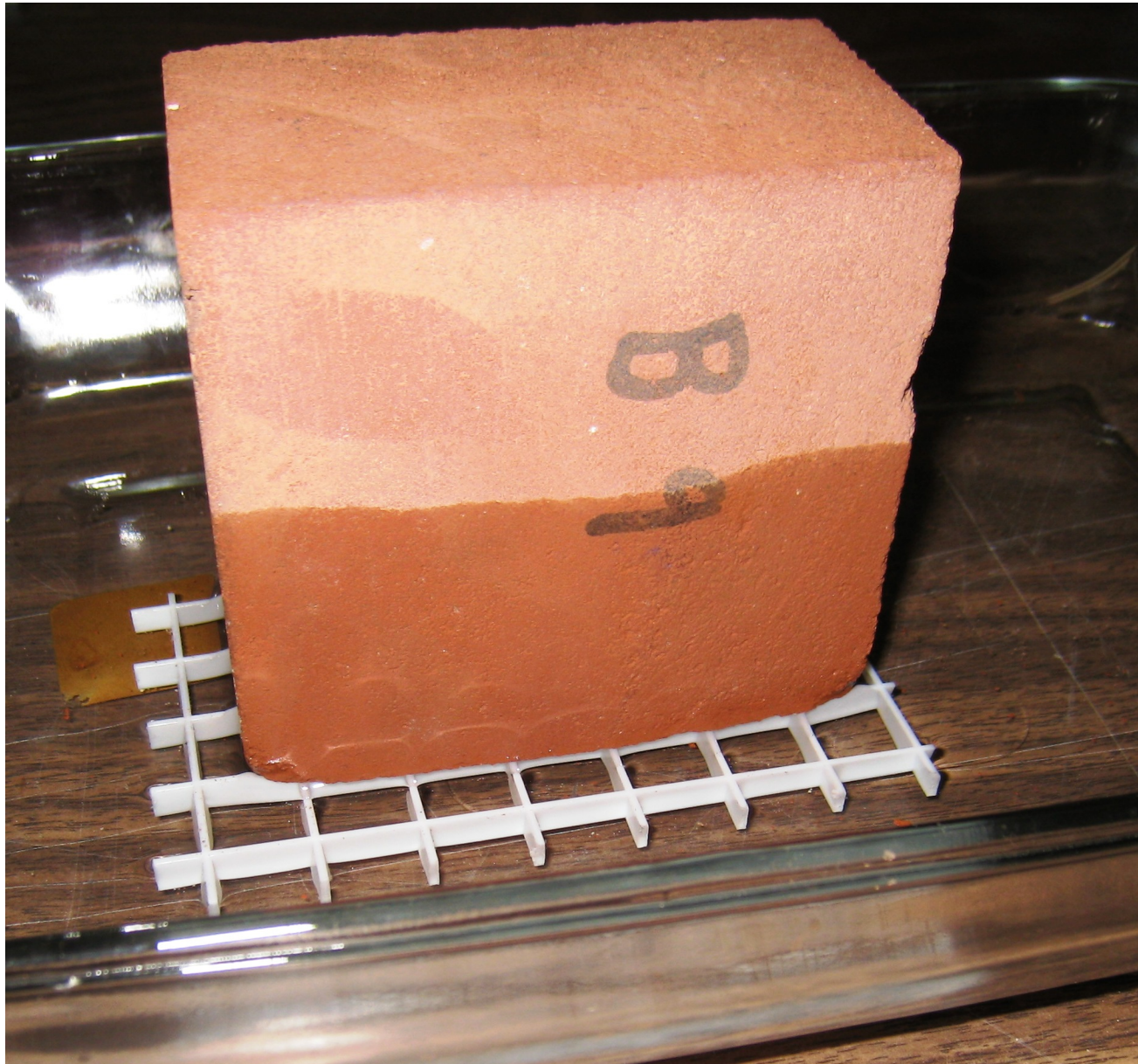
*Figure 1c. Gypsum, hydrated from plaster of paris and water, porosity 30 per cent.*

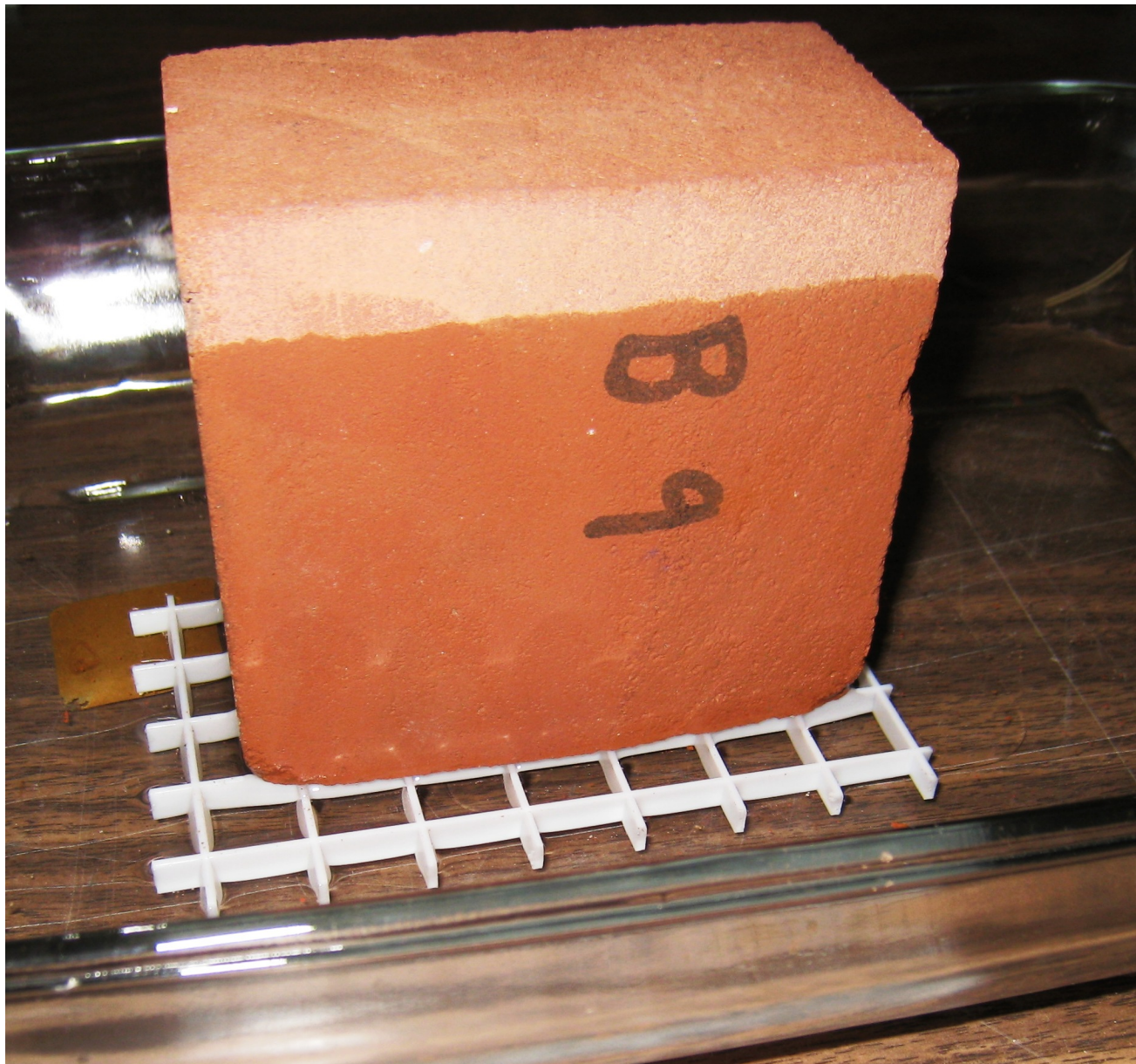


*Figure 1b. Brick, sintered clay, porosity 40 per cent.*

























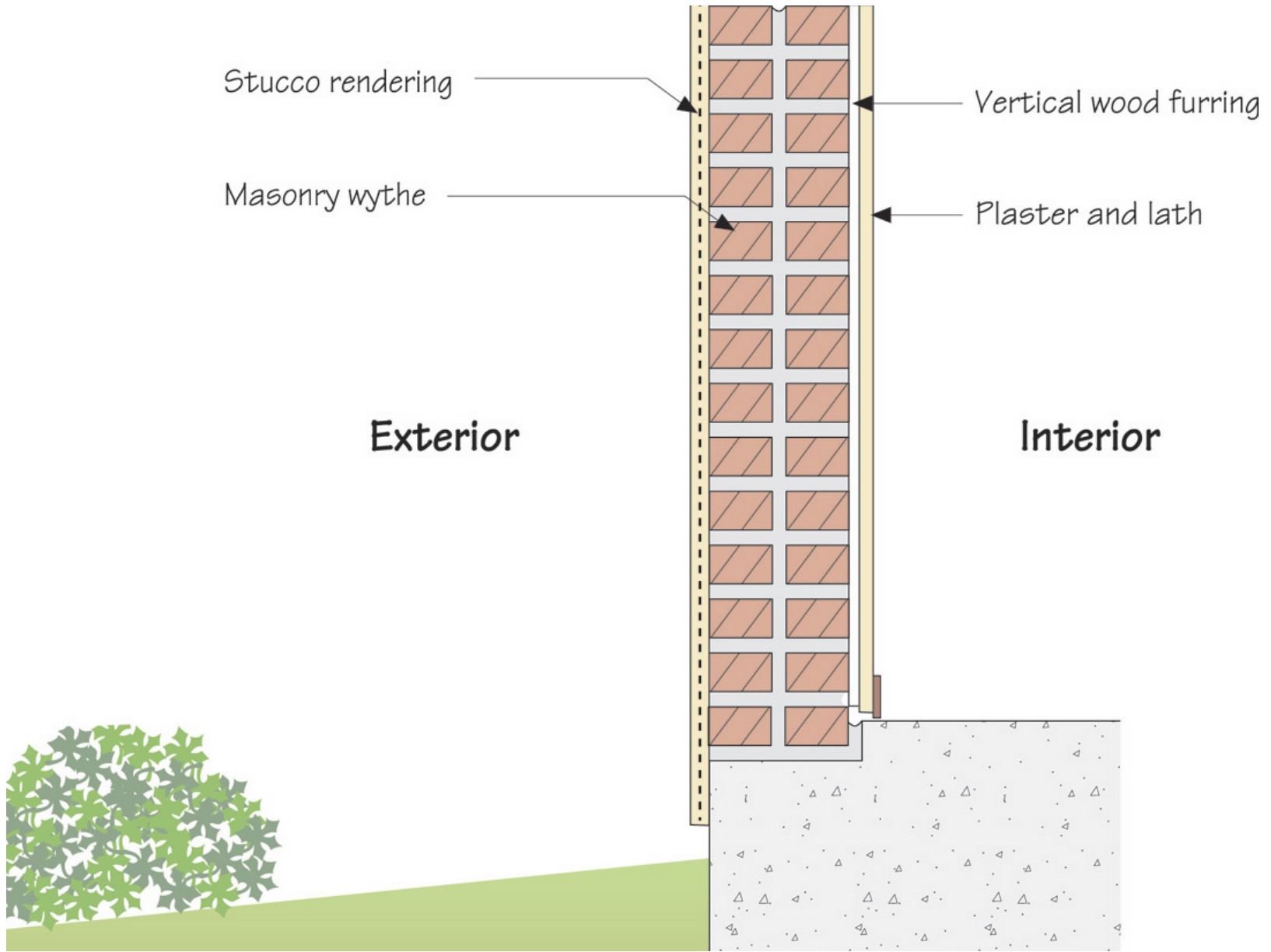












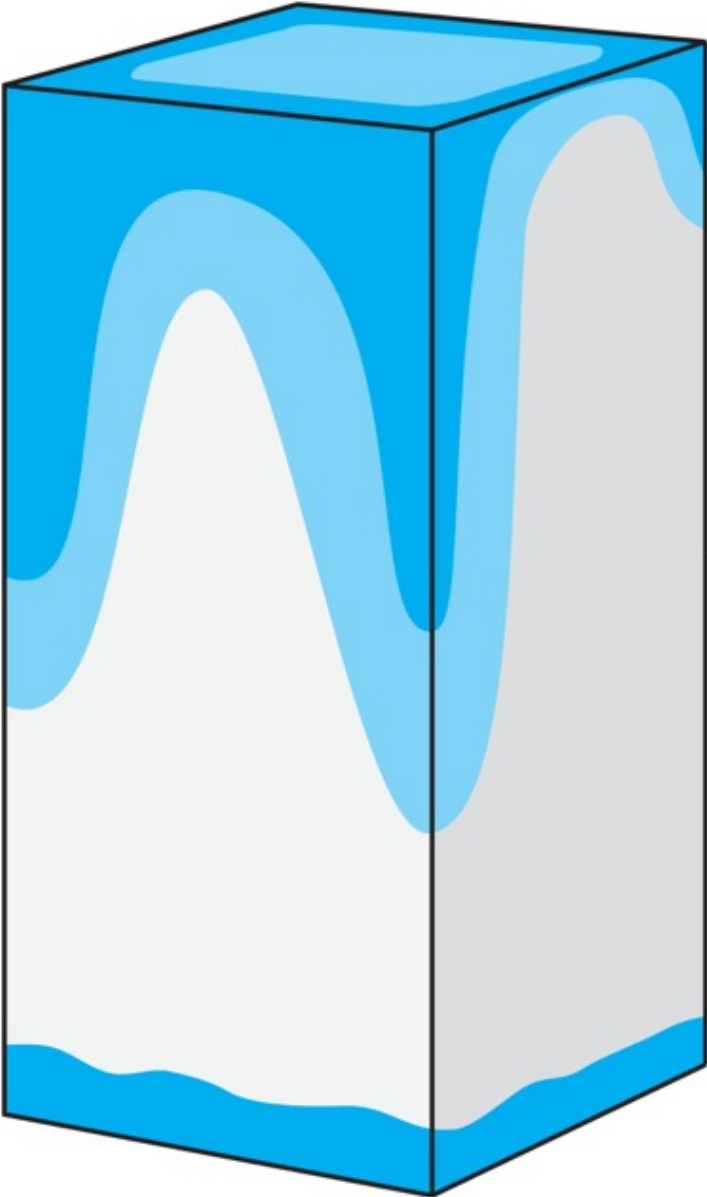


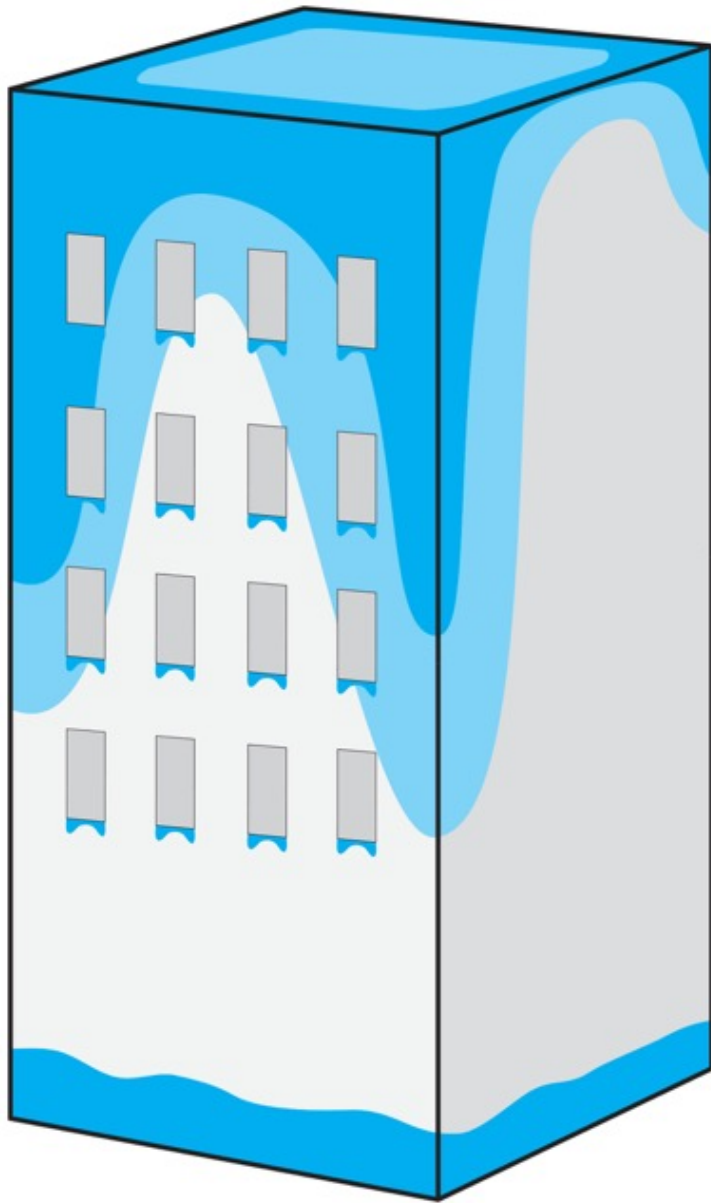














































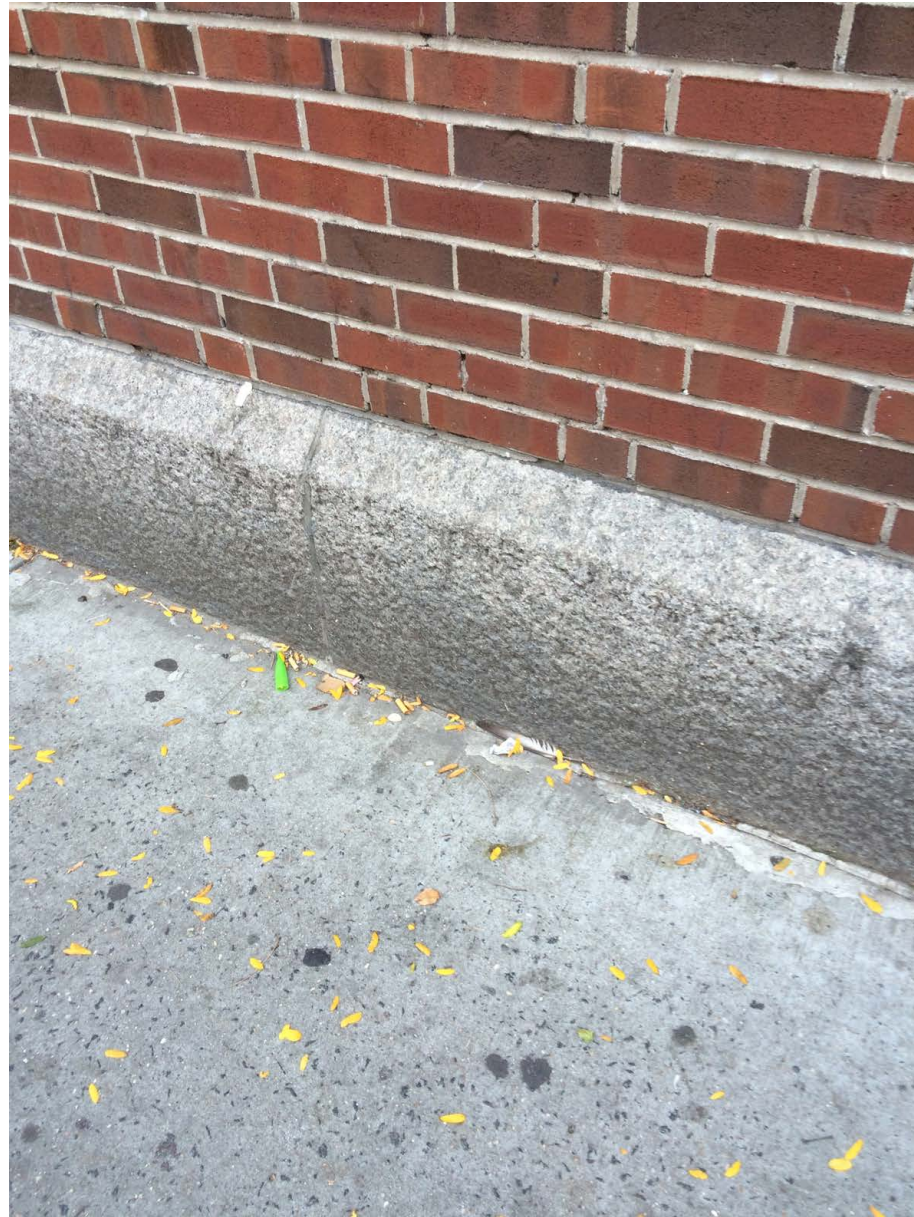


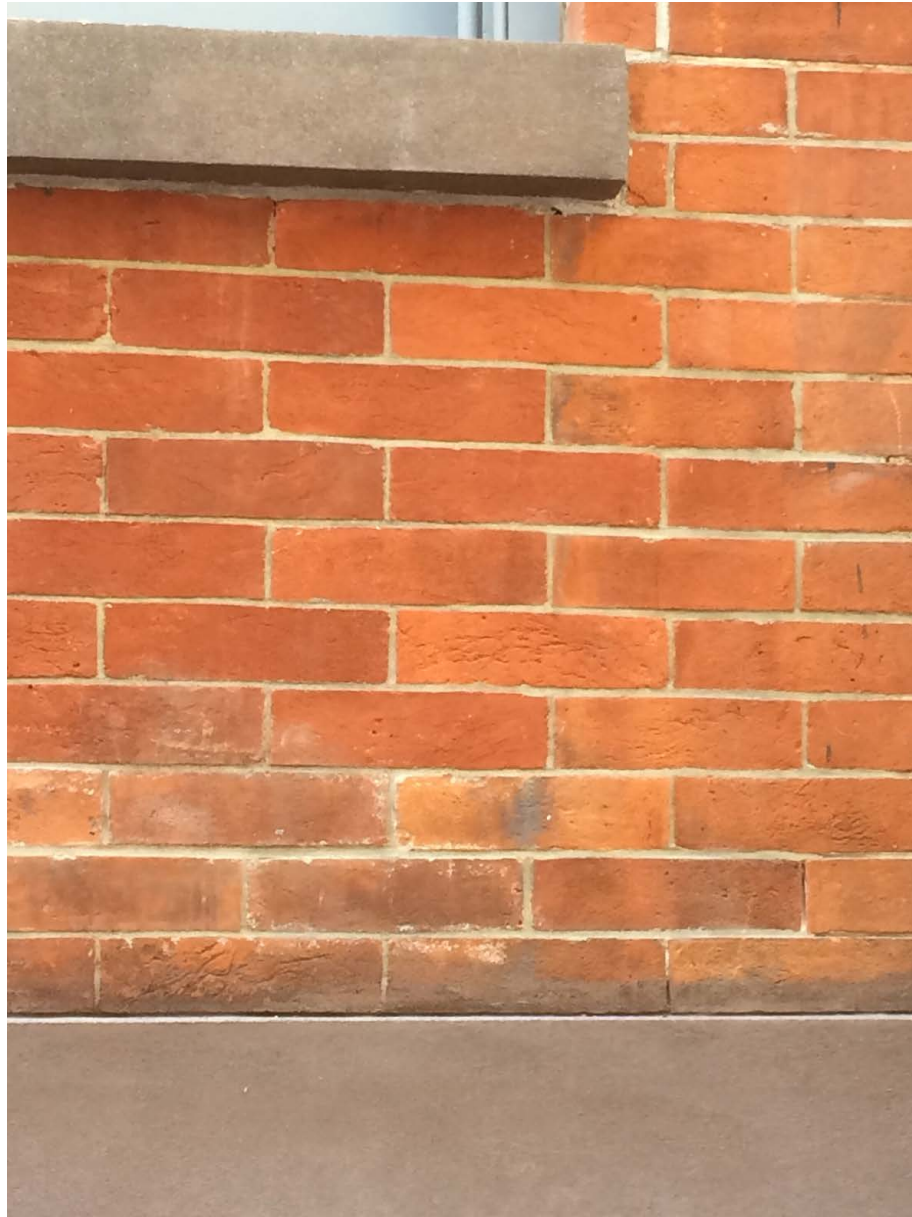












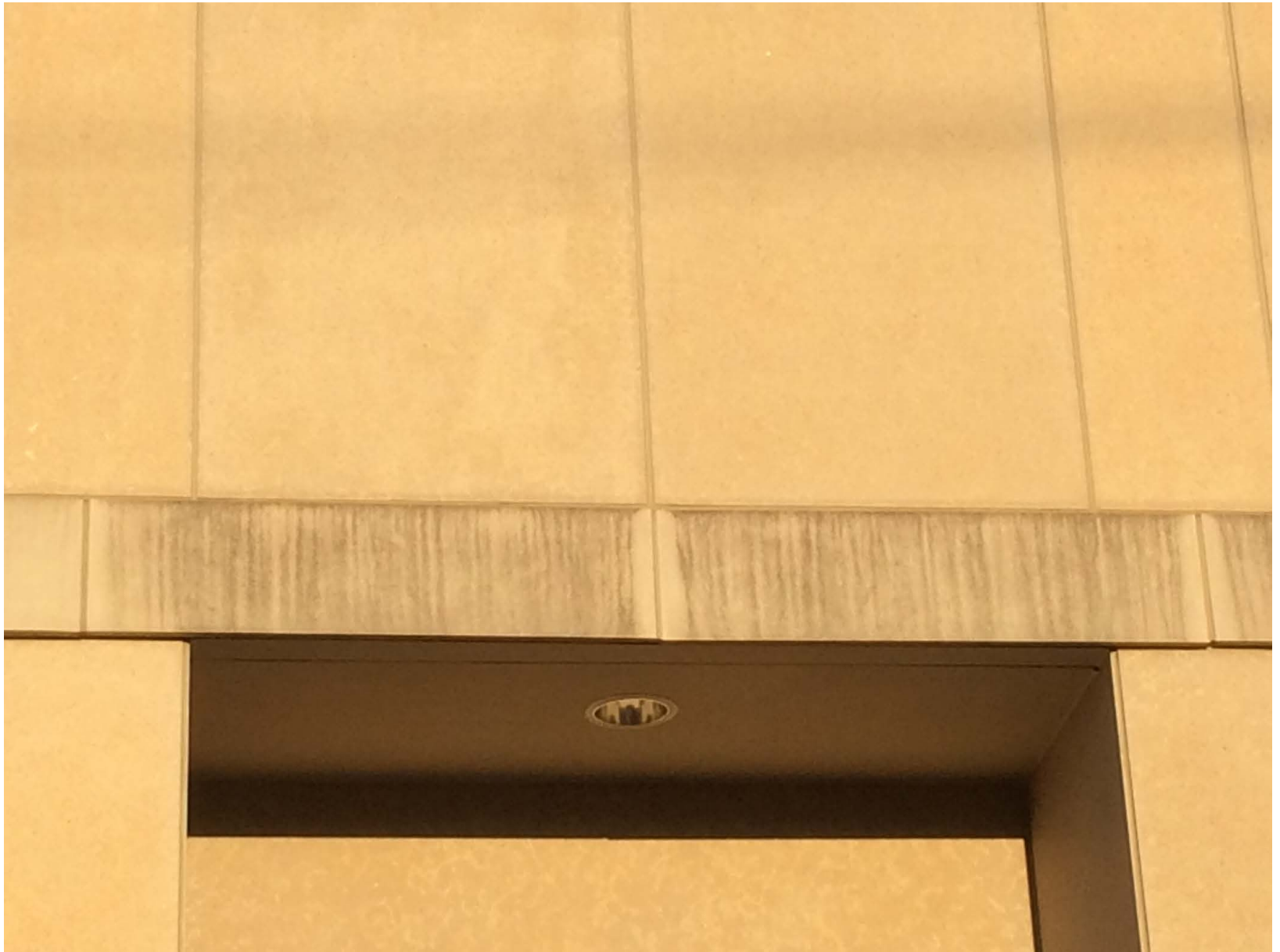






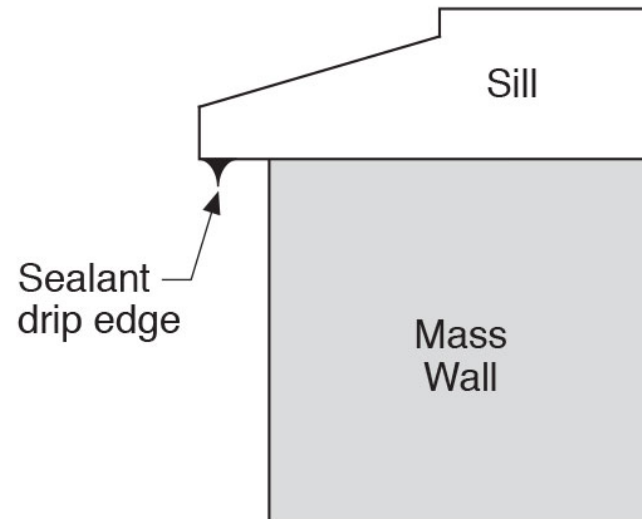
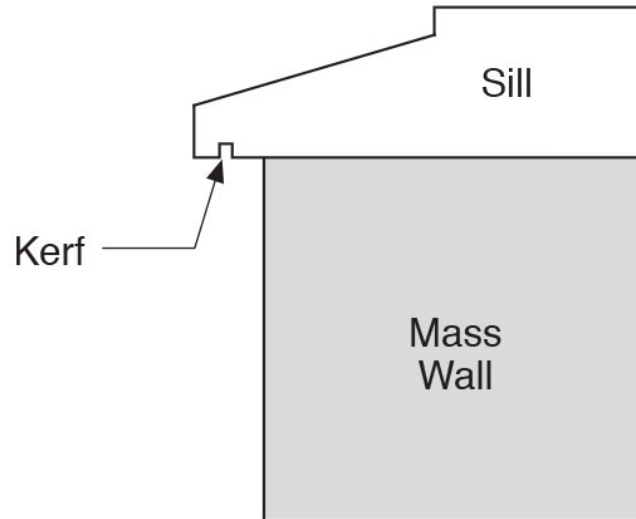


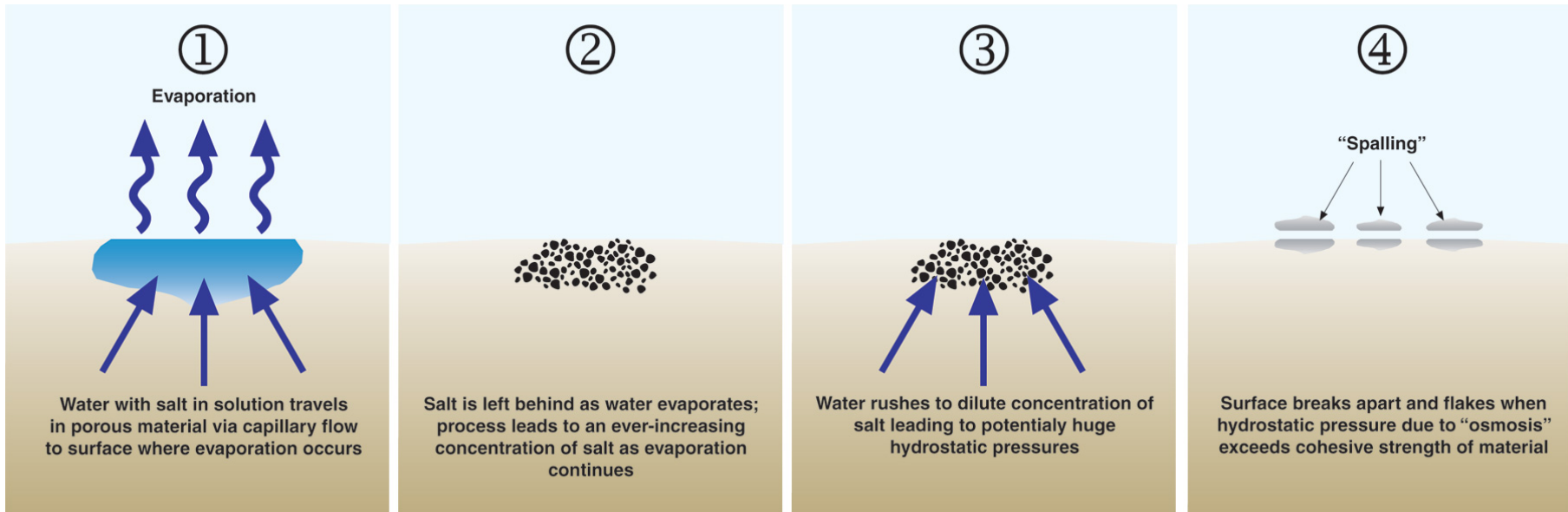












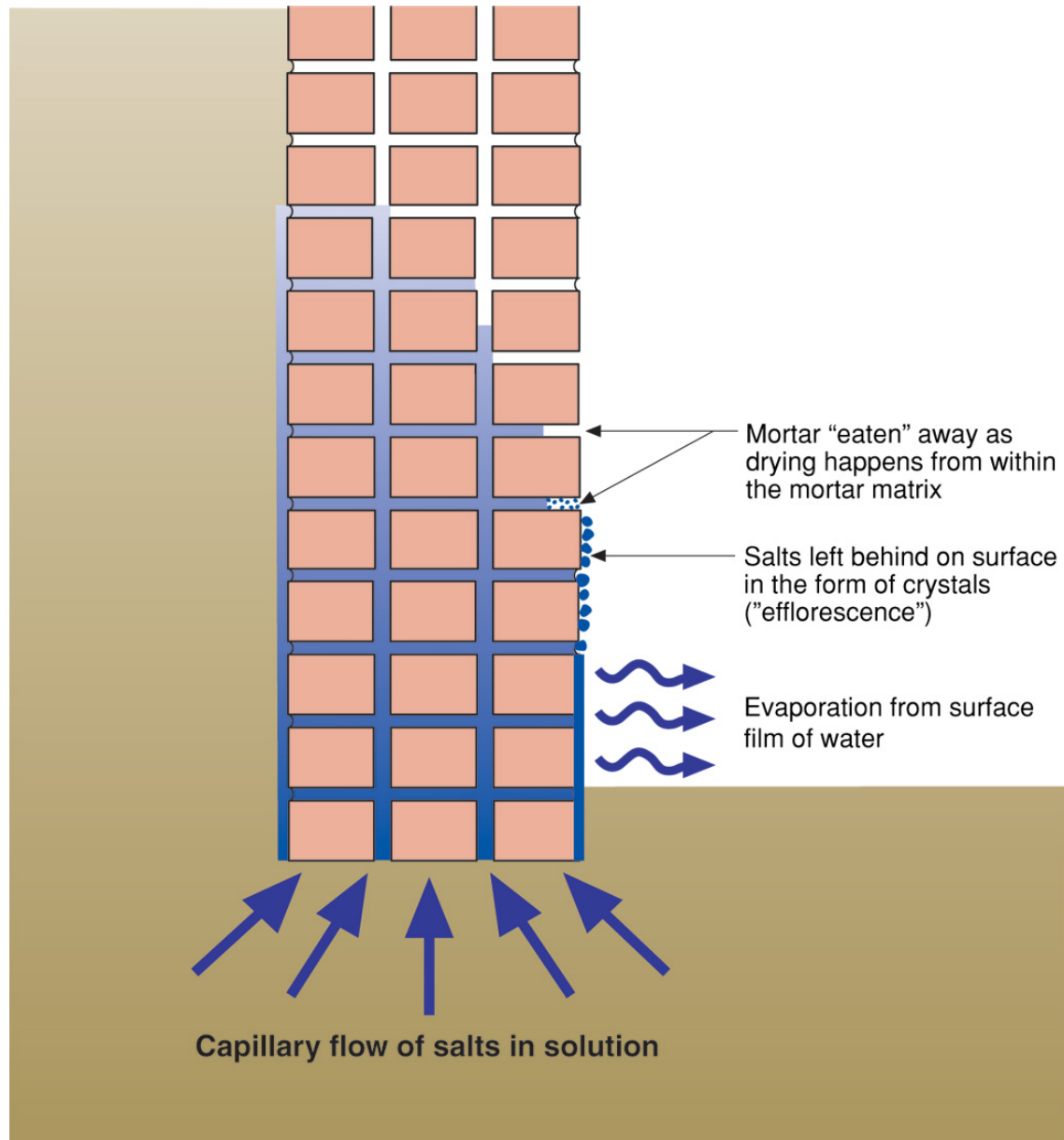
# Diffusion + Capillarity + Osmosis = Problem

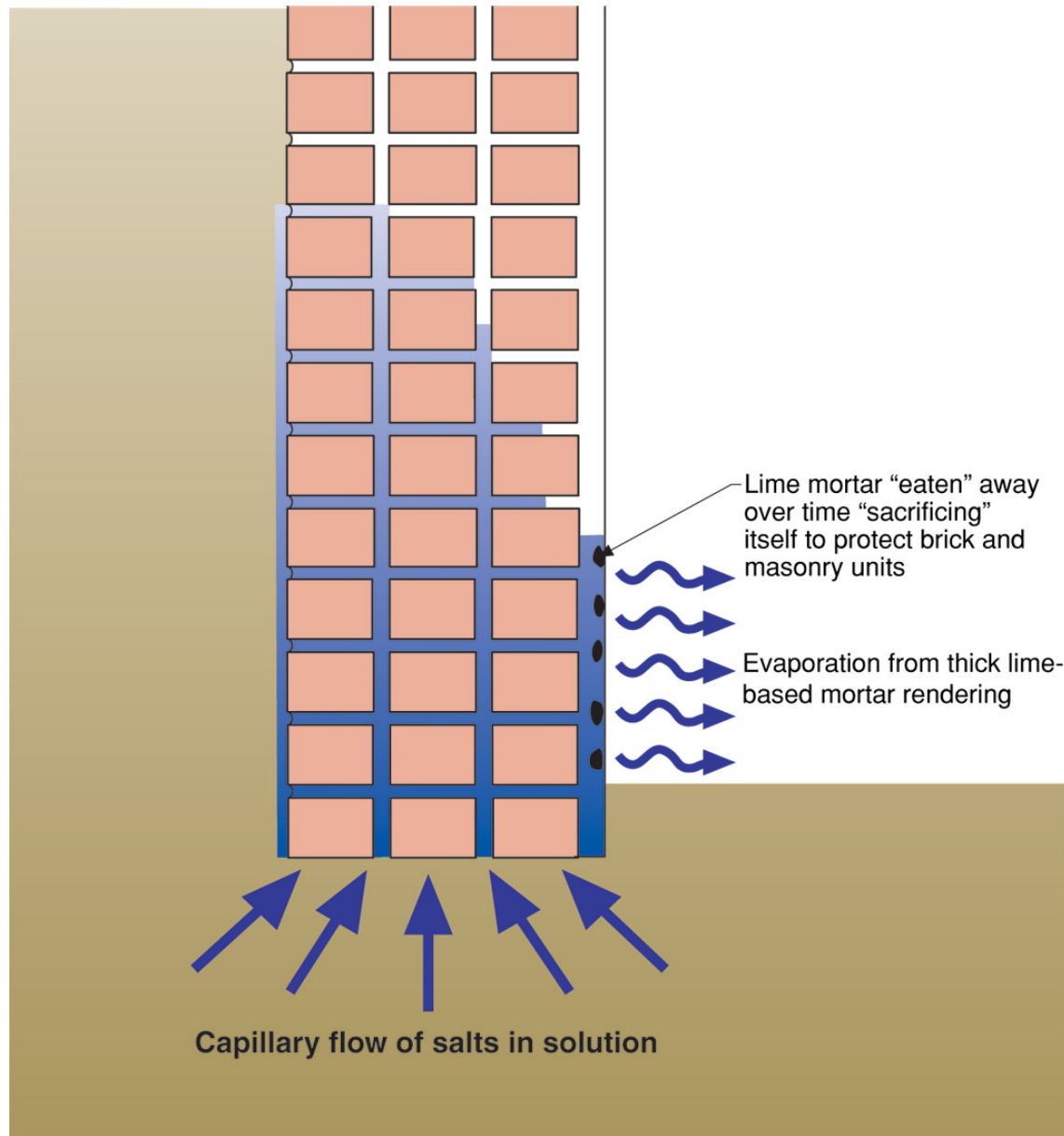
- Diffusion Vapor Pressure                      3 to 5 psi
- Capillary Pressure                                300 to 500 psi
- Osmosis Pressure                                 3,000 to 5,000 psi

















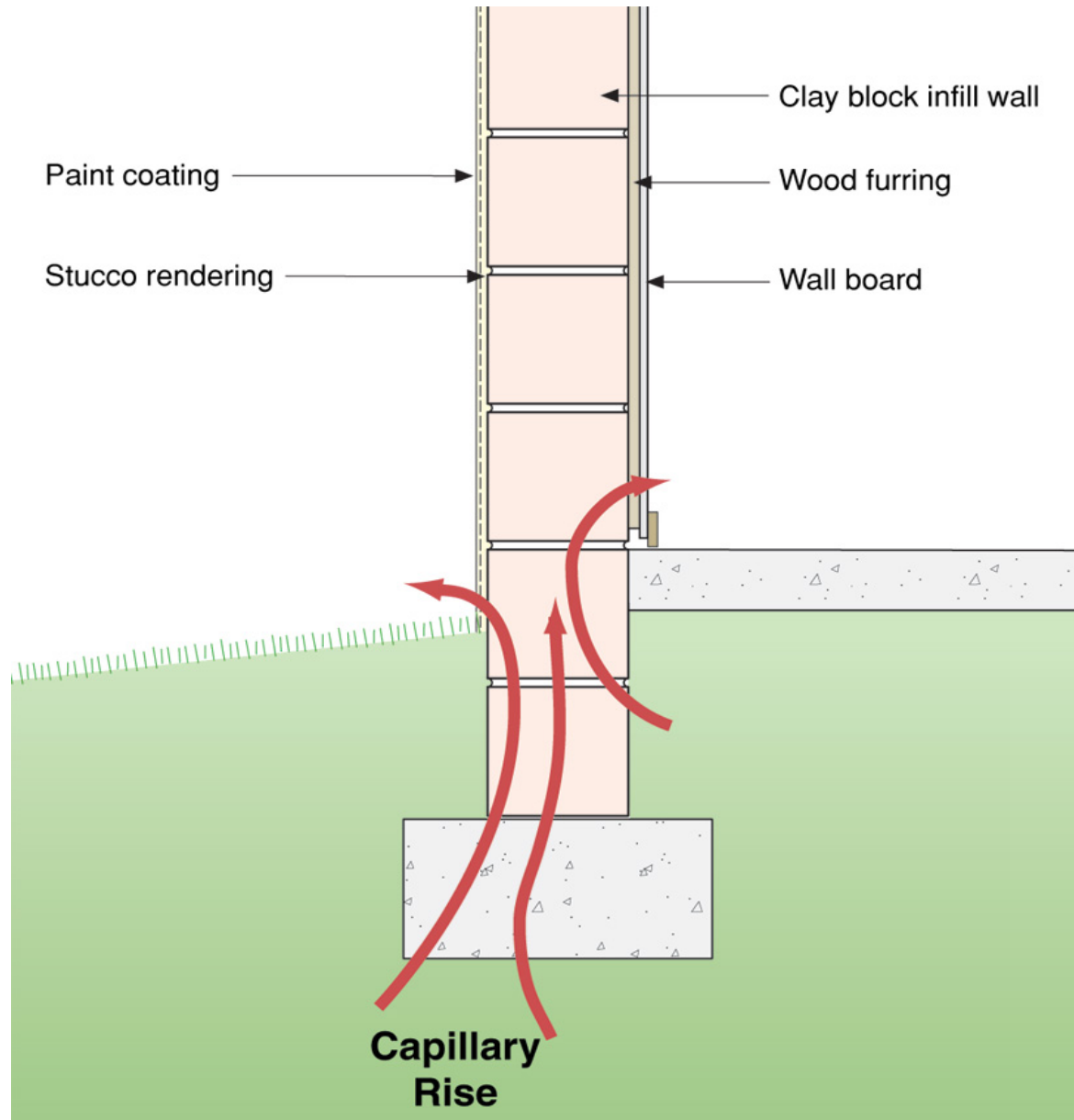


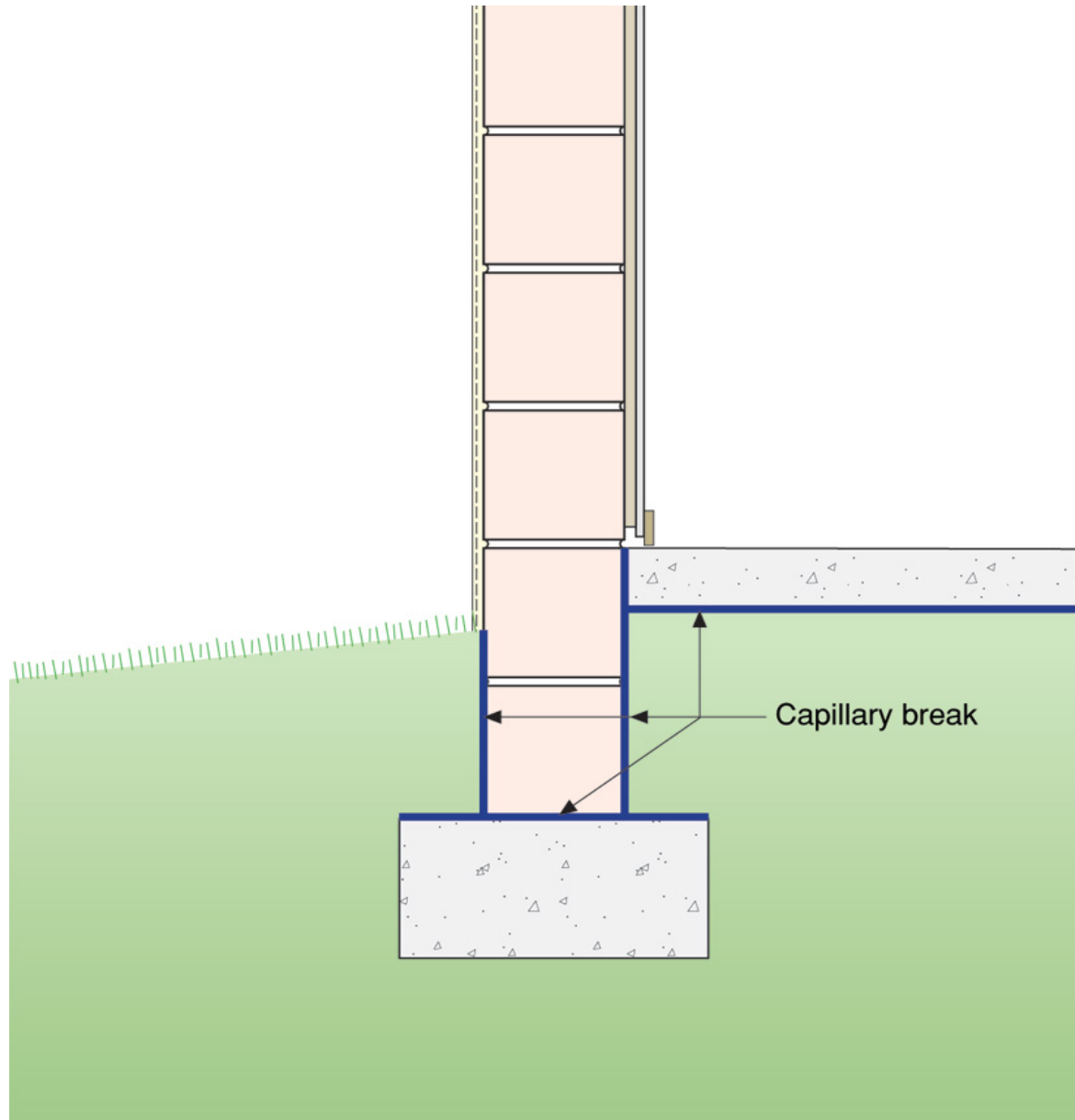


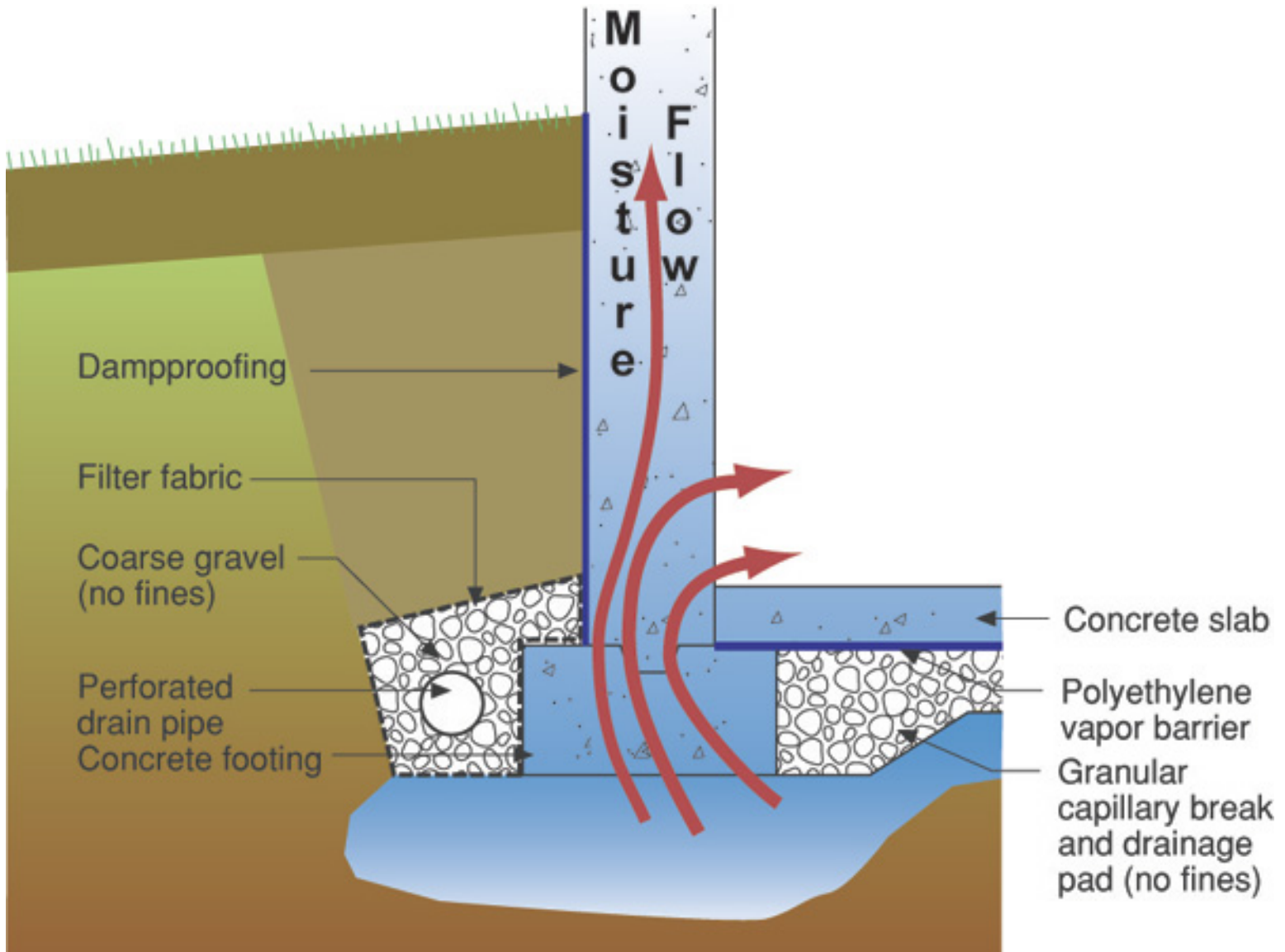


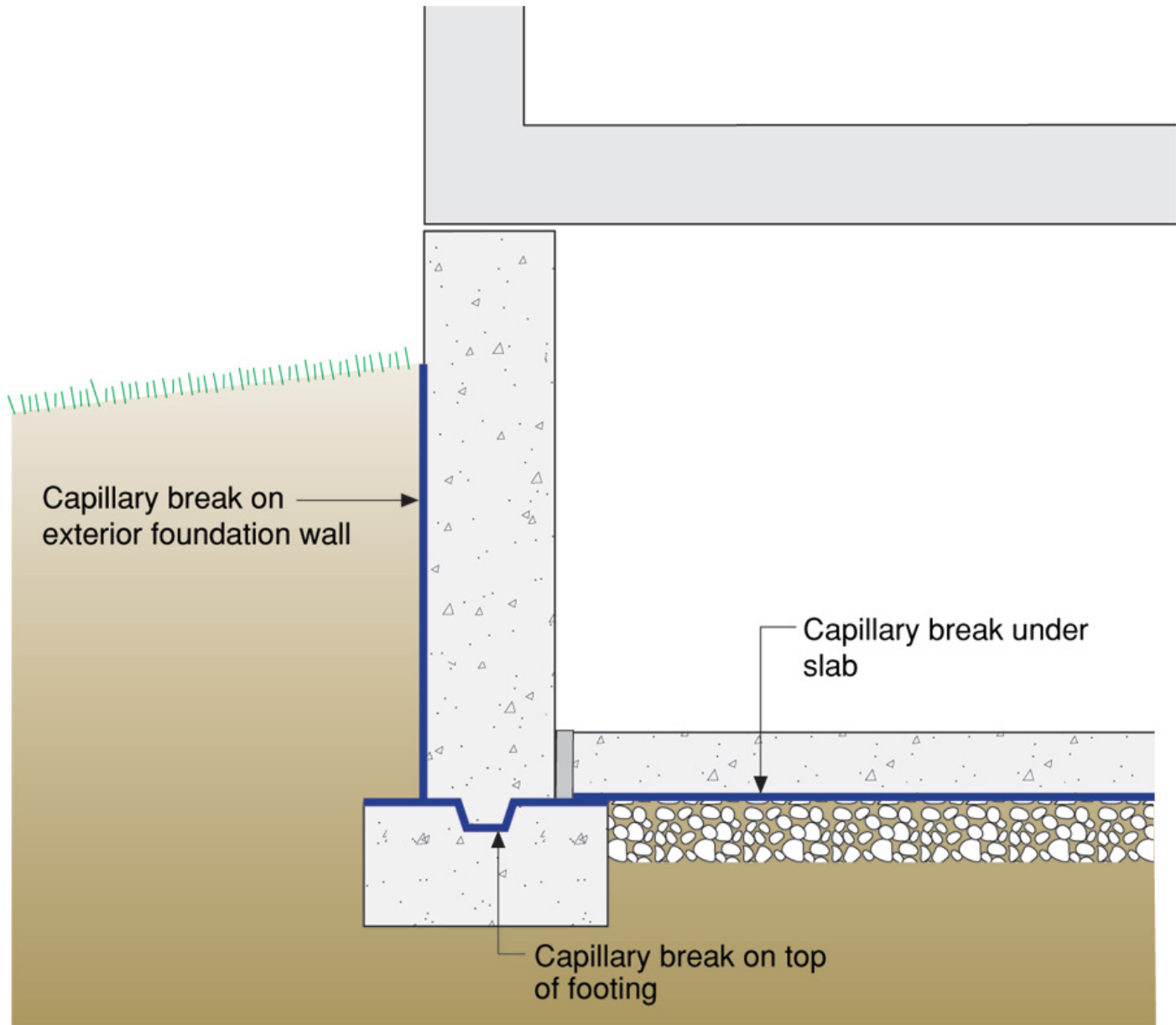


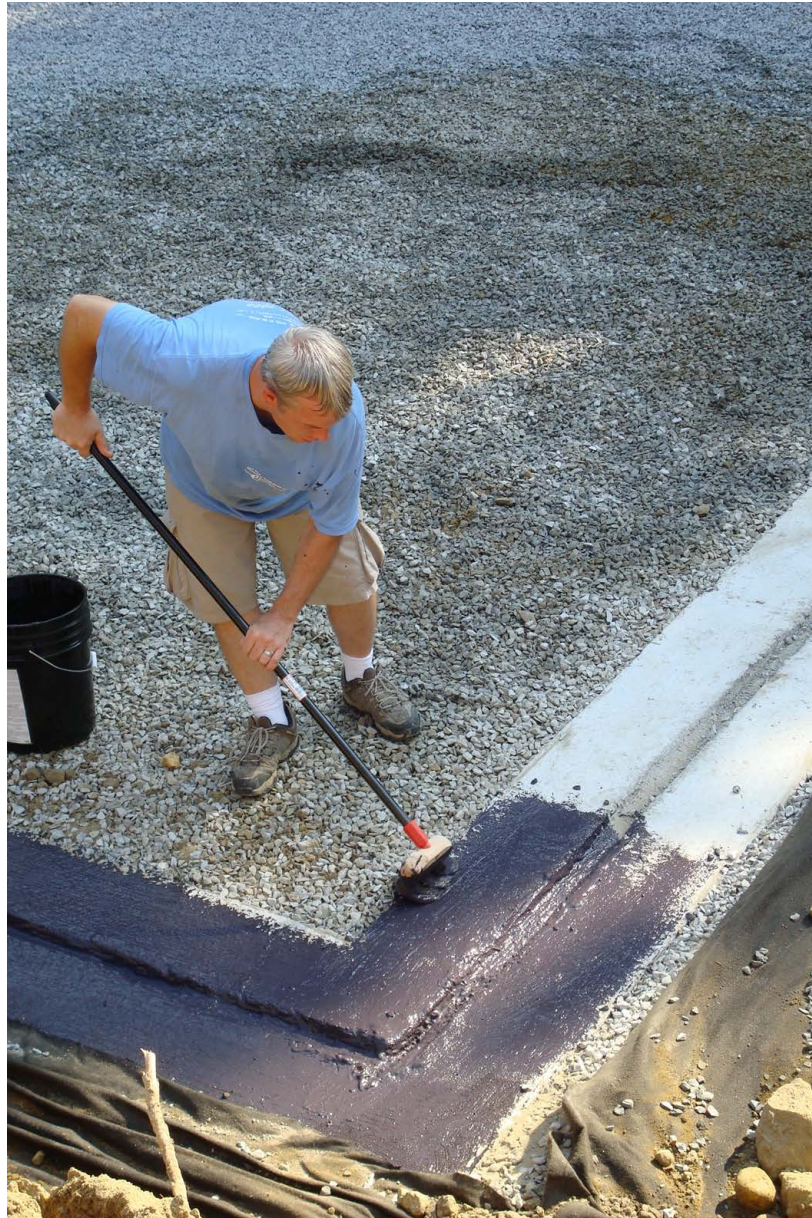


















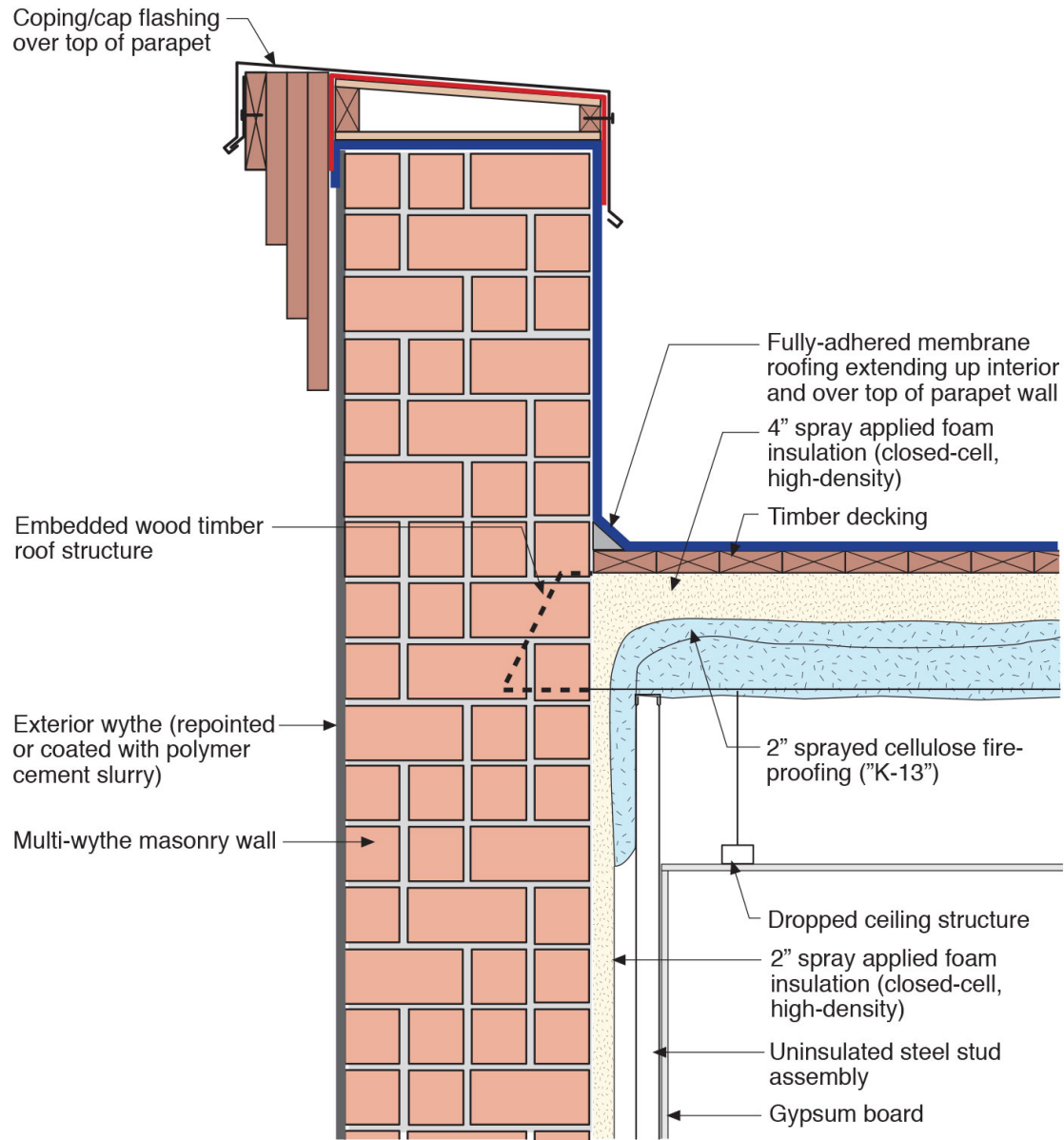








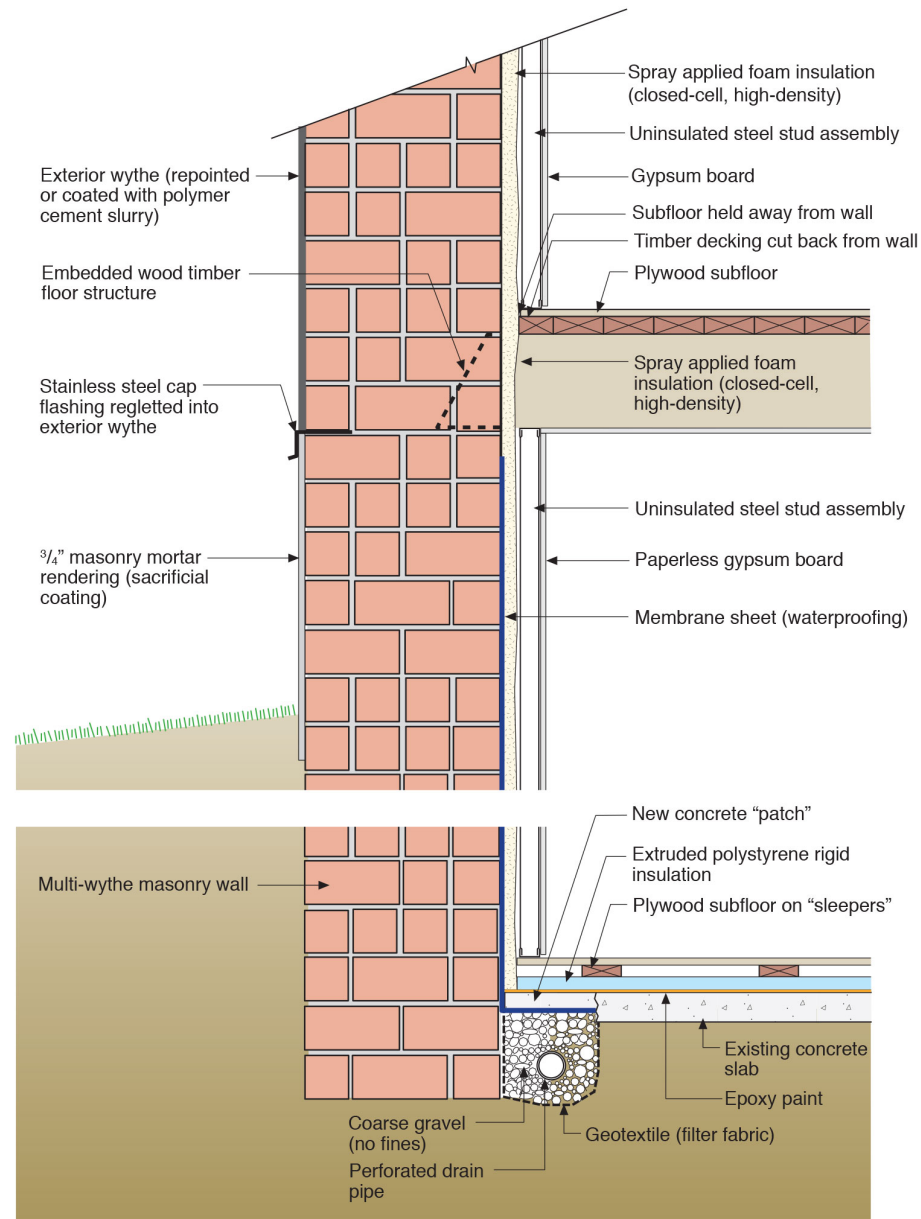


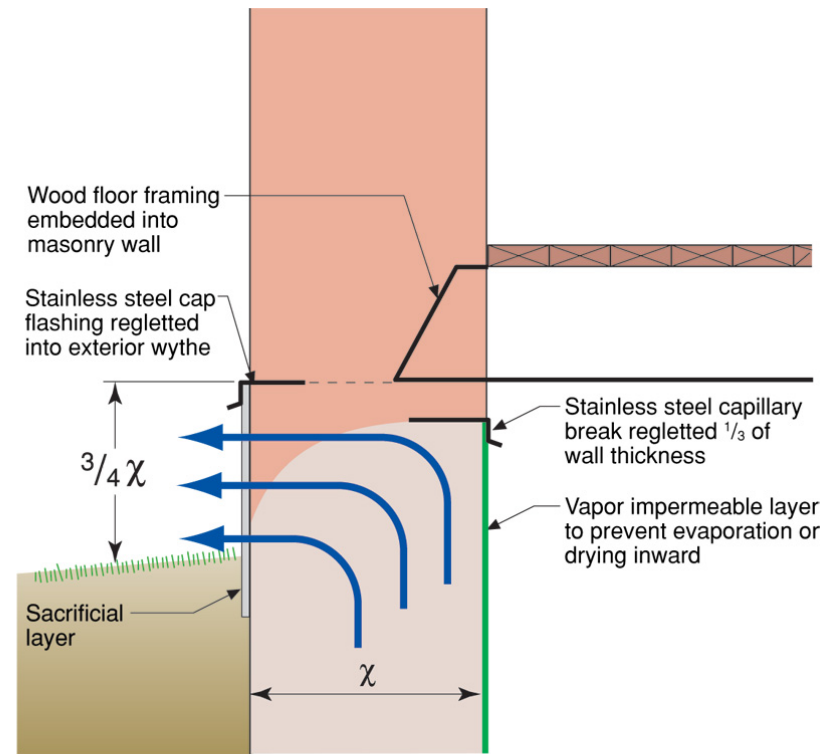
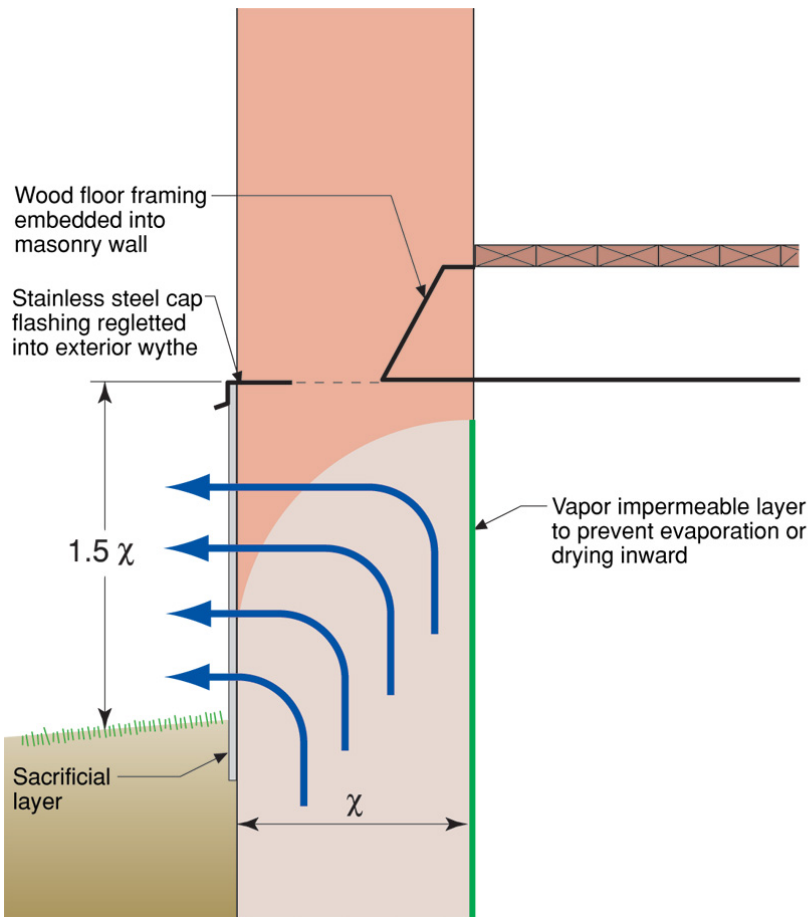


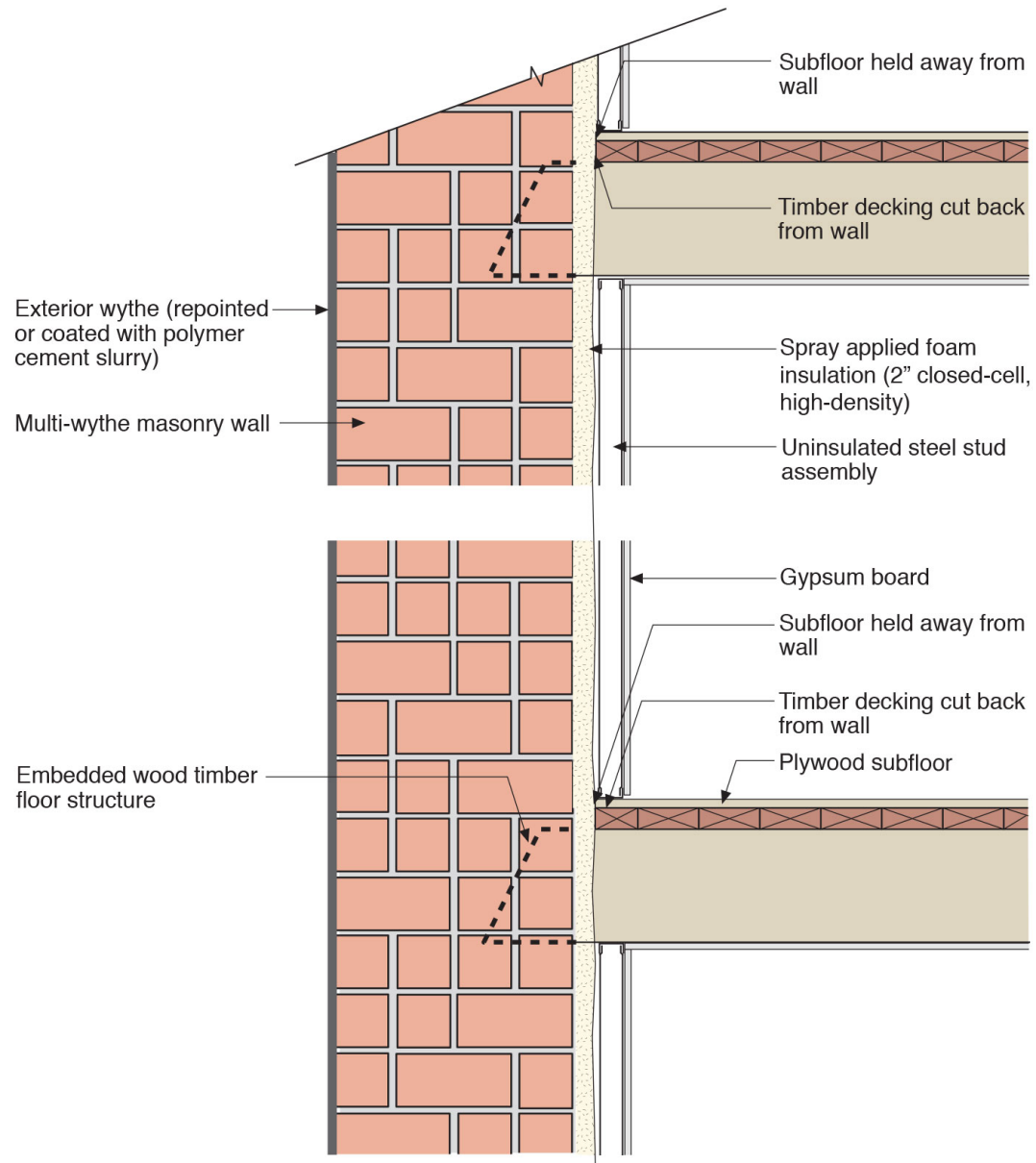


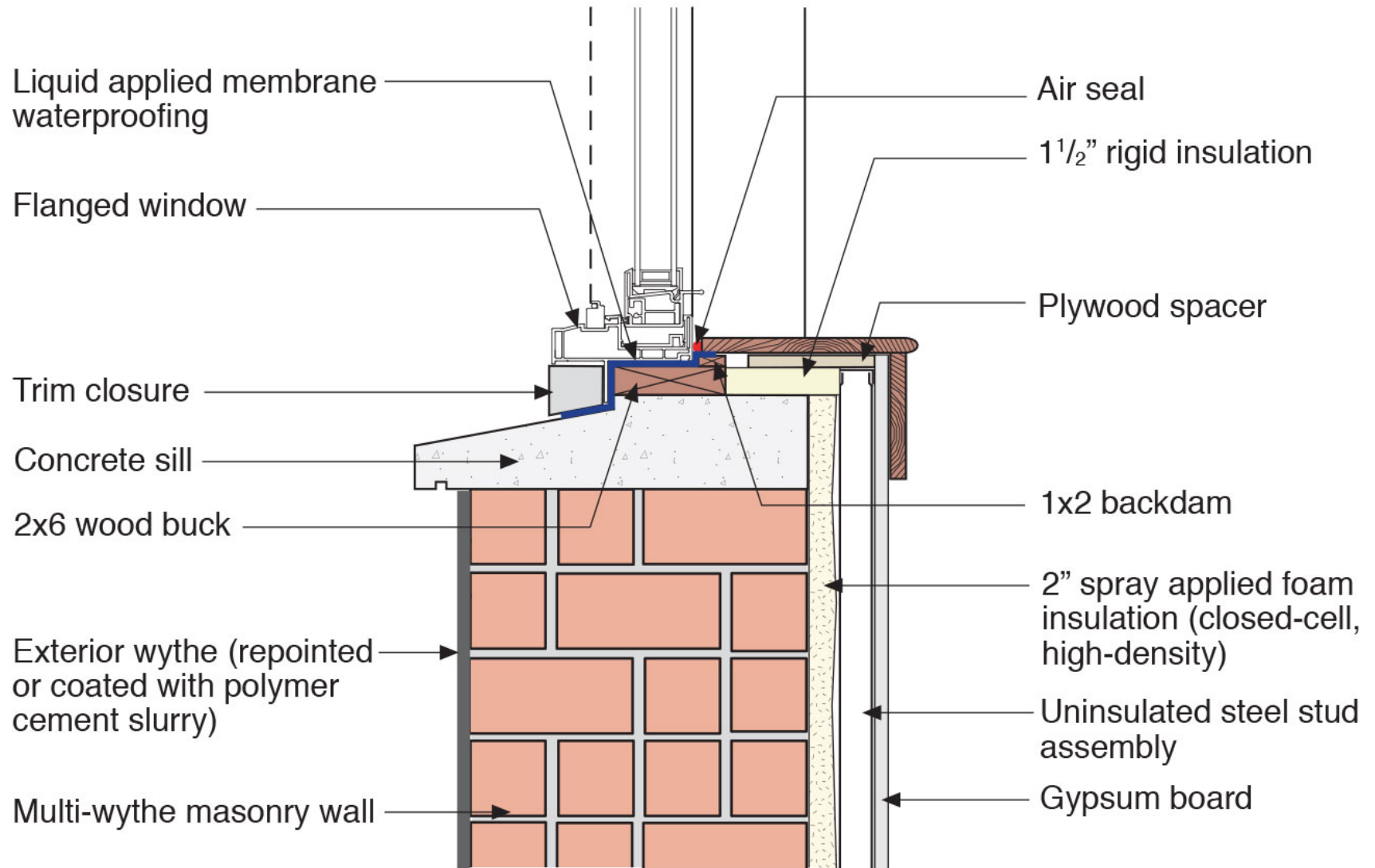
















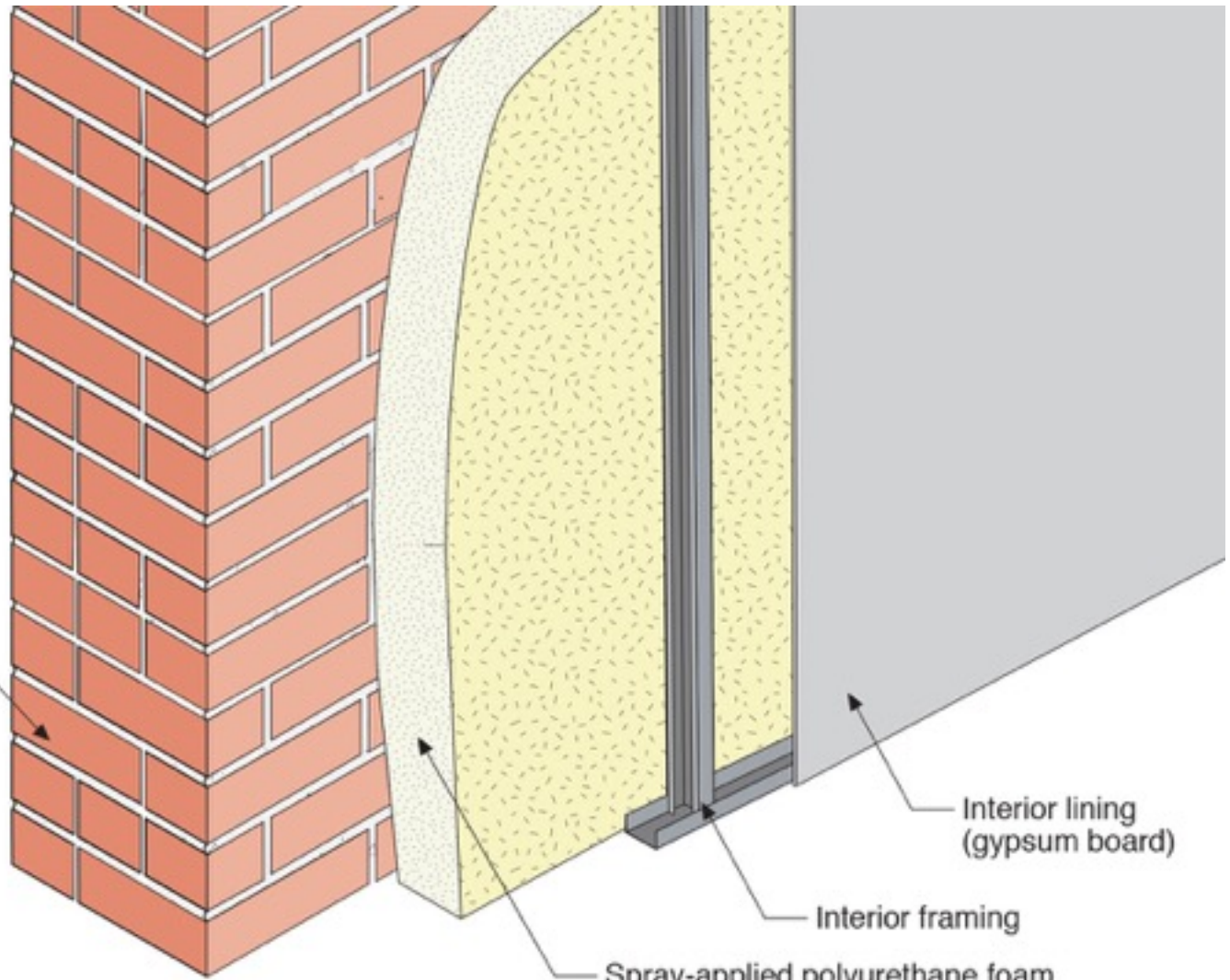








Multi-wythe mass wall

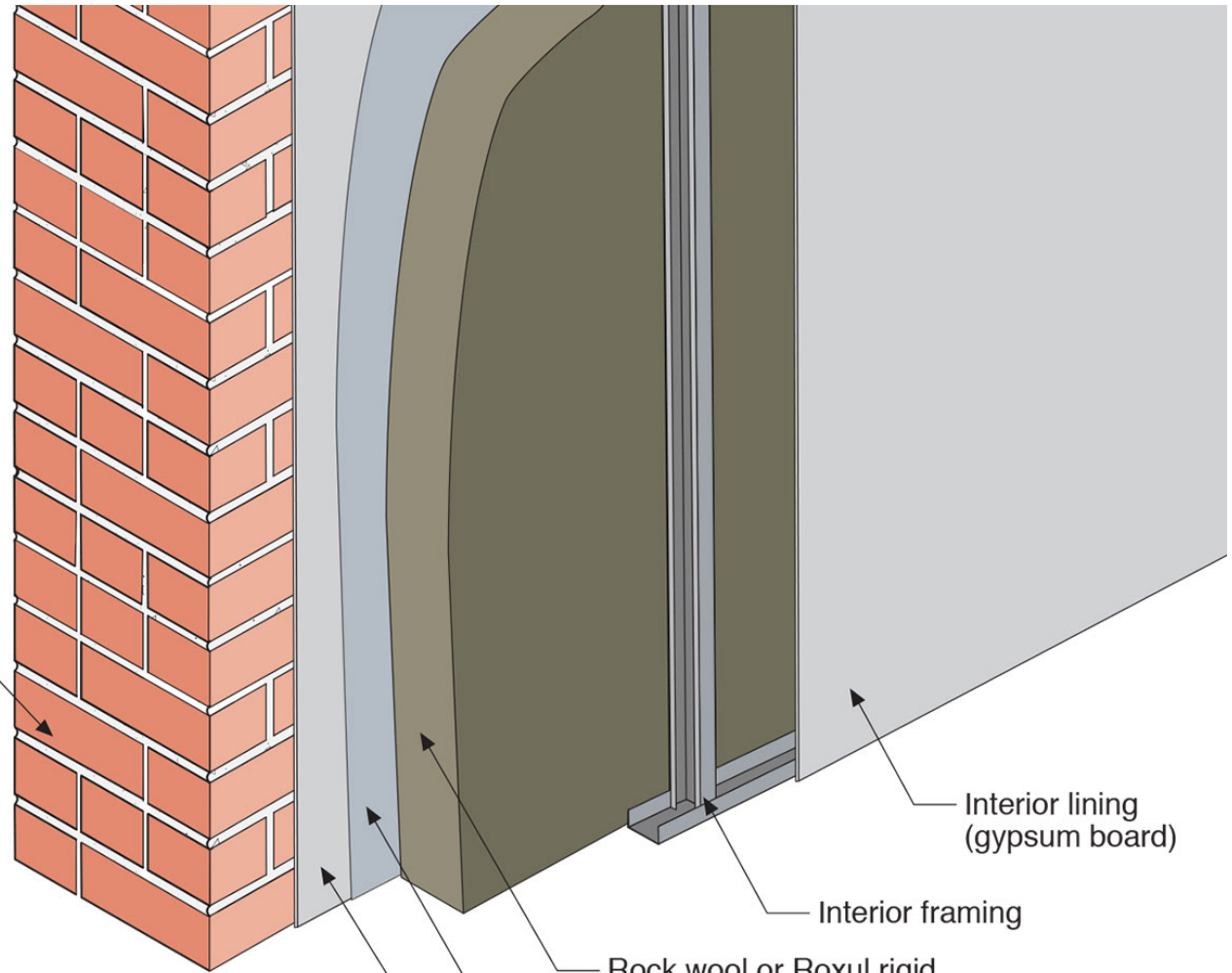


Interior lining  
(gypsum board)

Interior framing

Spray-applied polyurethane foam  
(2 lb/ft<sup>3</sup> density)

Multi-wythe mass wall



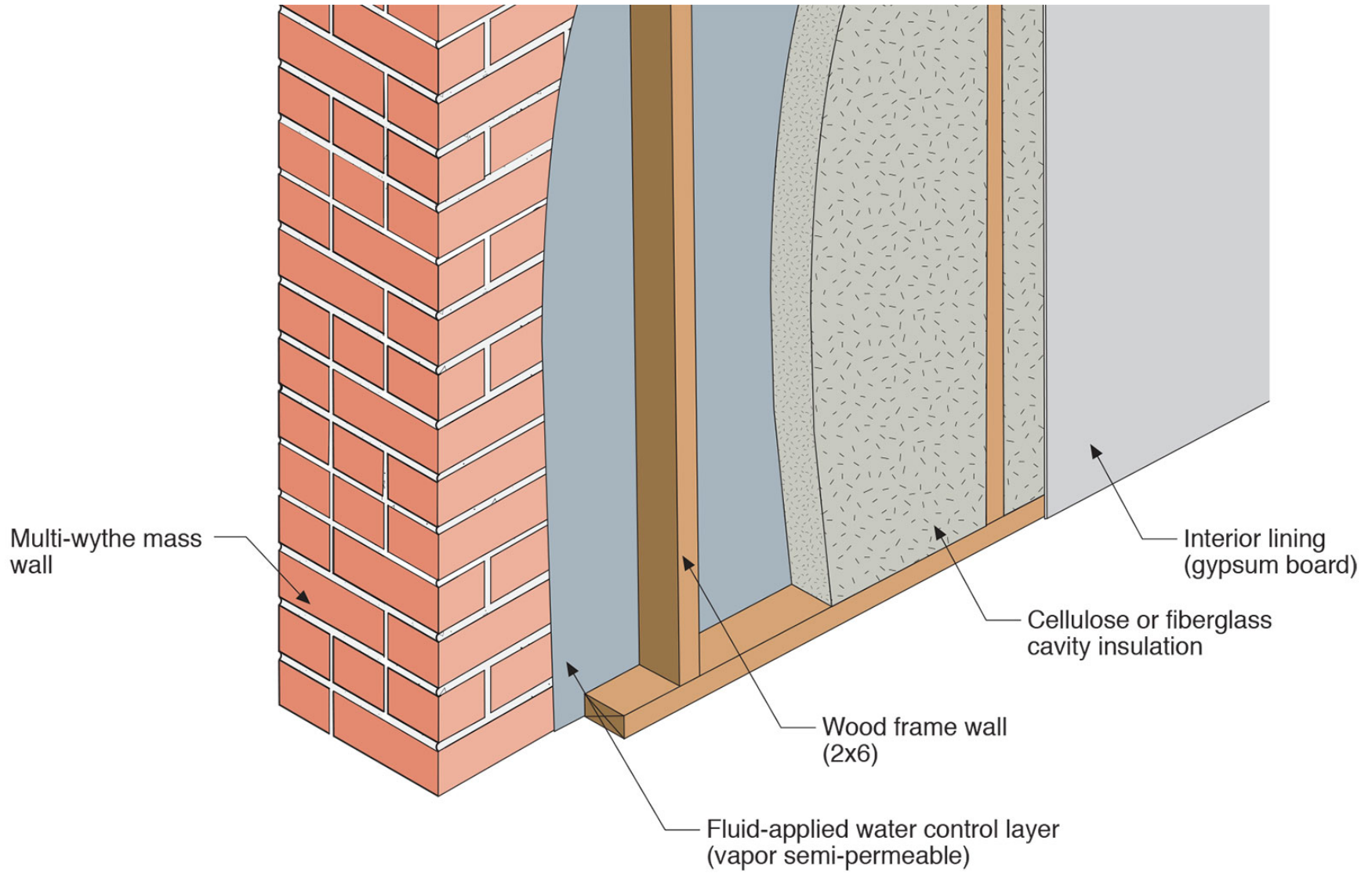
Interior lining (gypsum board)

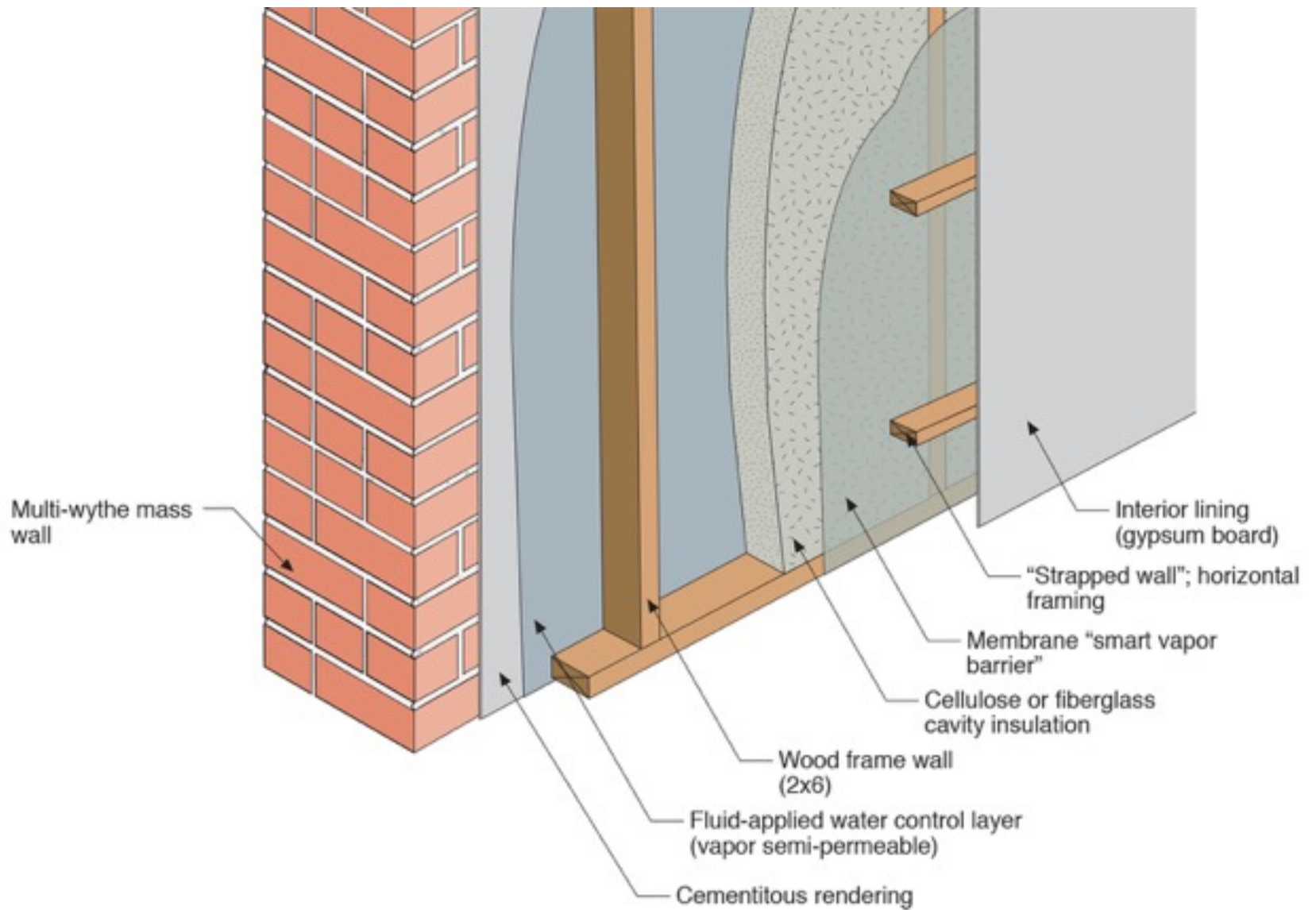
Interior framing

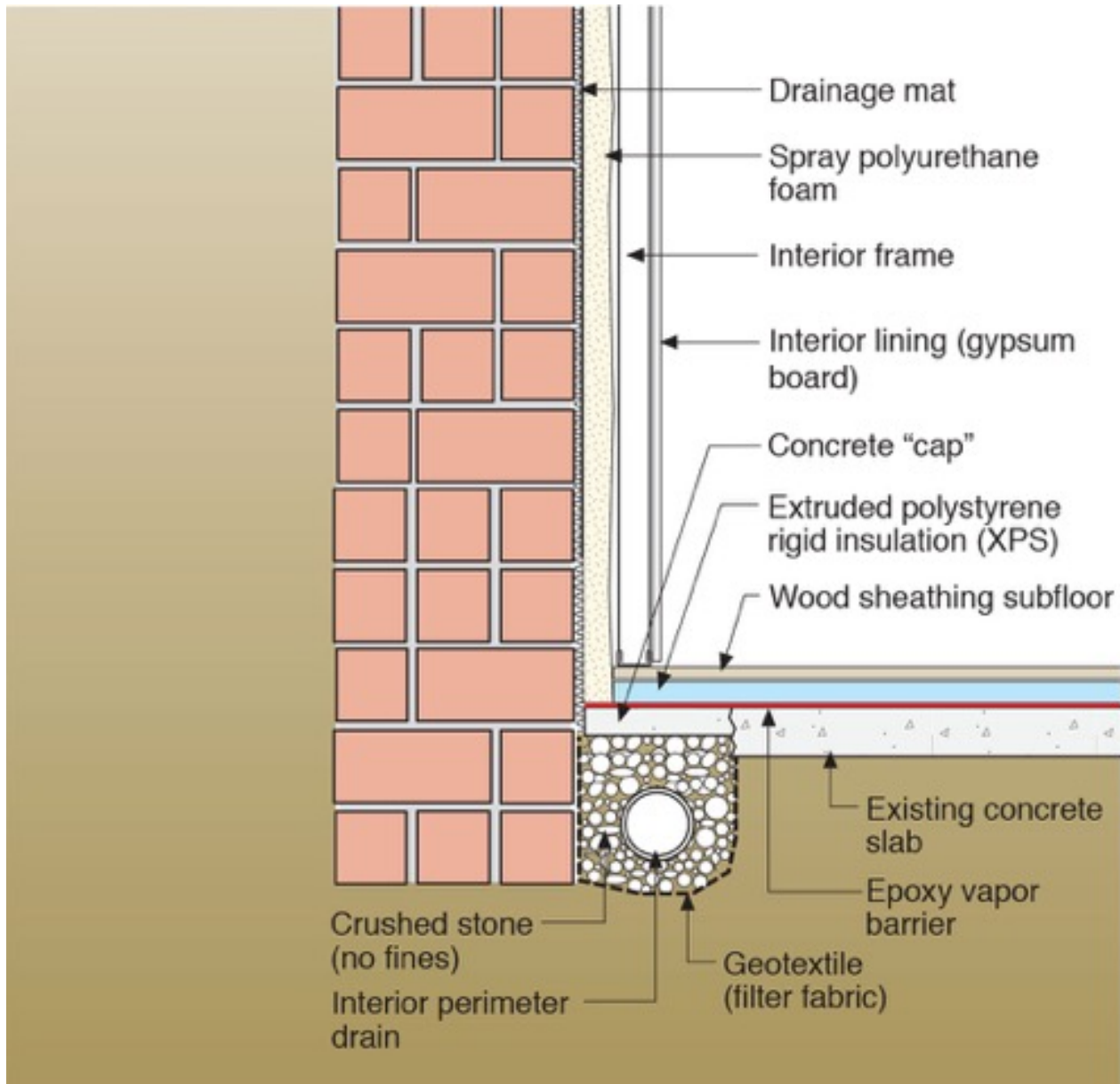
Rock wool or Roxul rigid mineral wool insulation

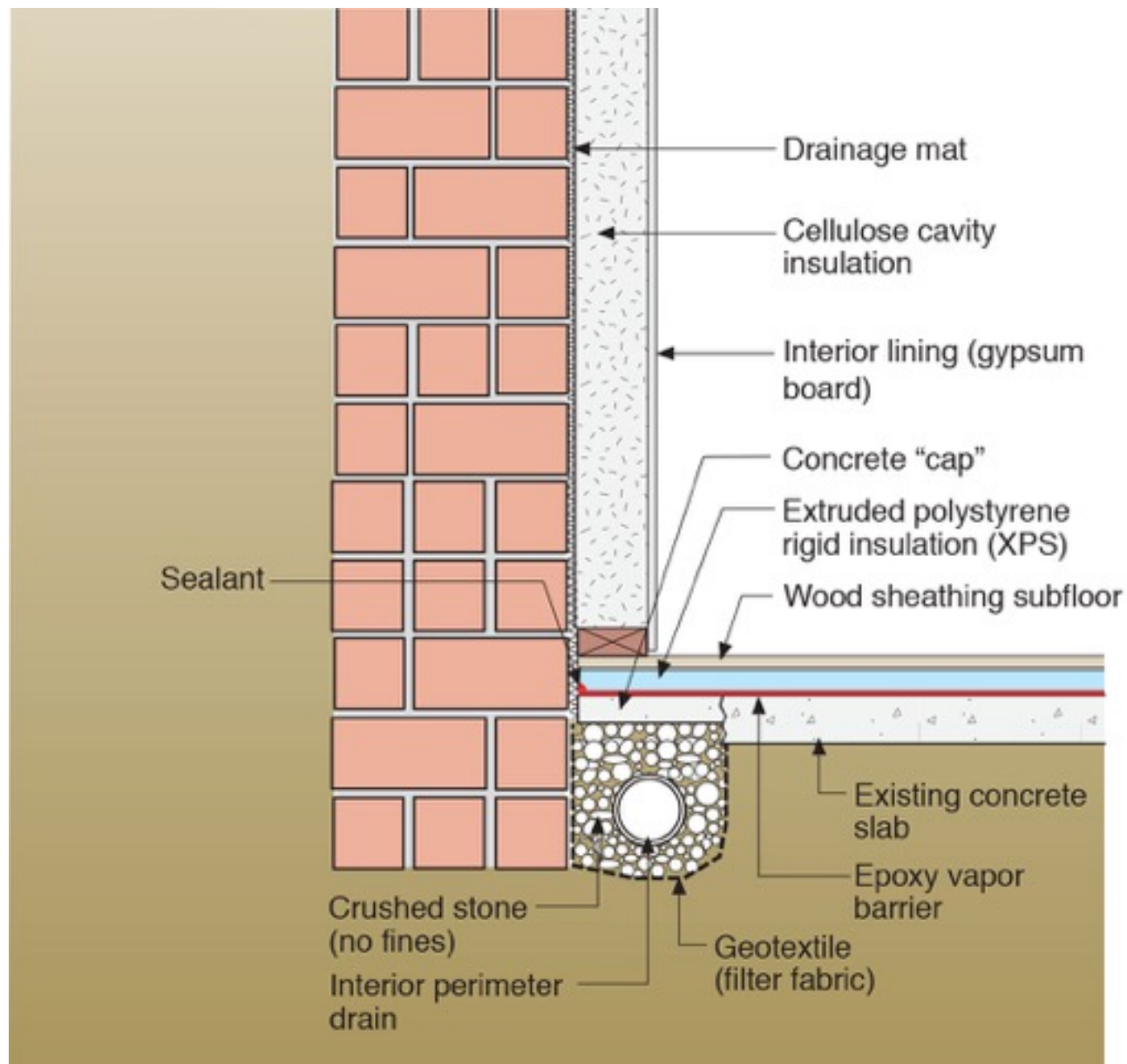
Fluid-applied water control layer (vapor semi-permeable)

Cementitious rendering

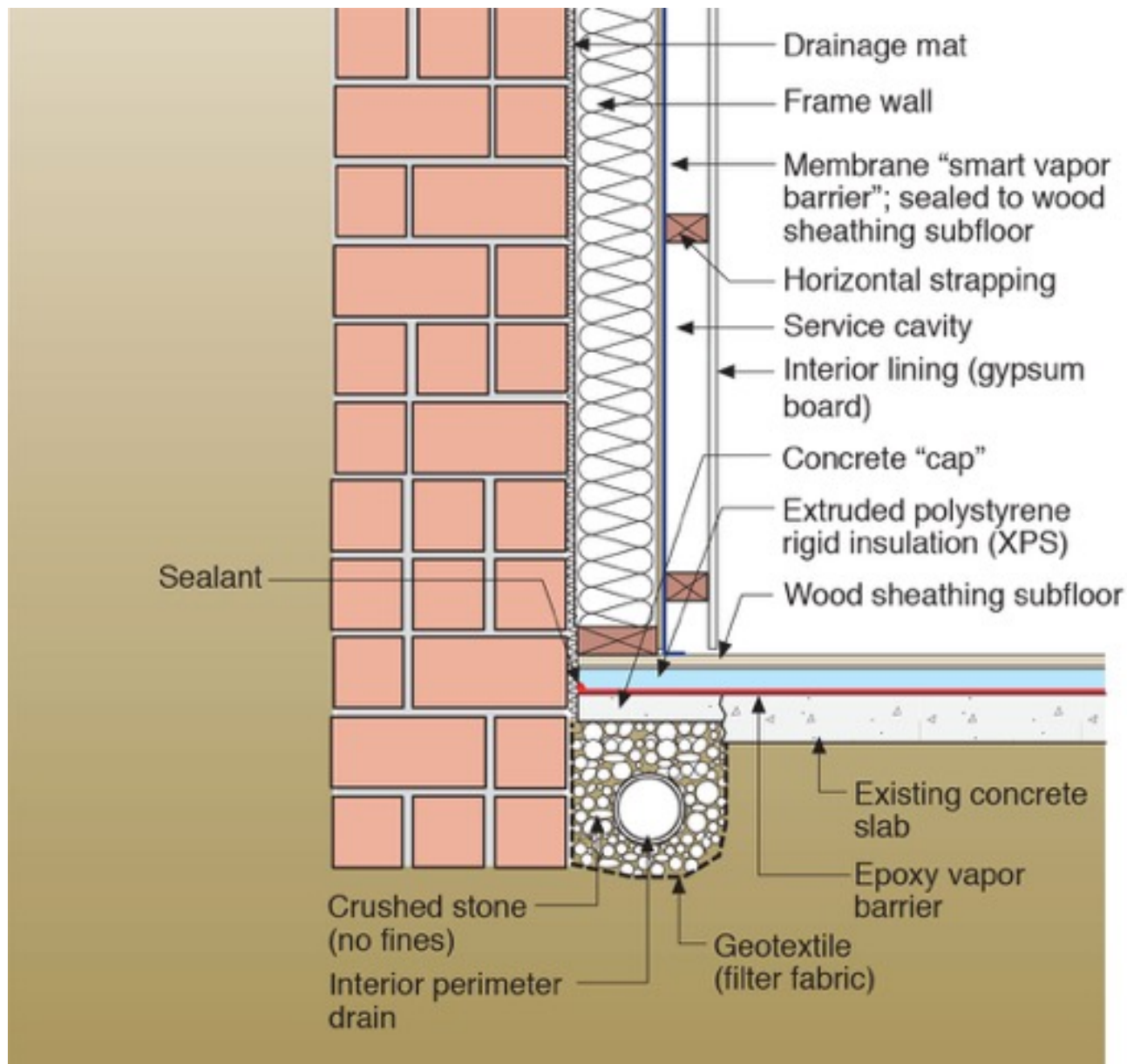












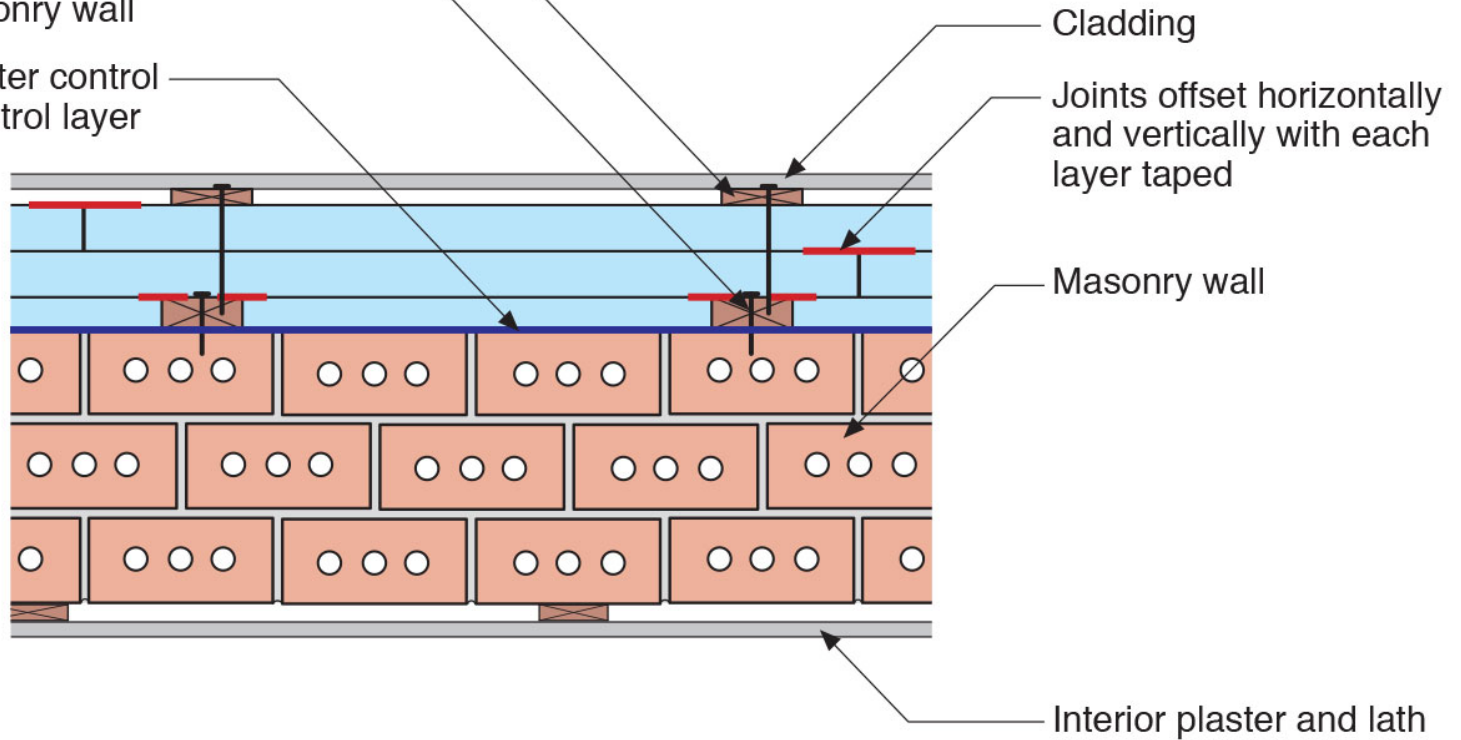




1x4 wood furring attached through rigid insulation to 2x4 wood furring

2x4 wood furring mechanically attached to masonry wall

Fluid-applied water control layer and air control layer



Cladding

Joints offset horizontally and vertically with each layer taped

Masonry wall

Interior plaster and lath



