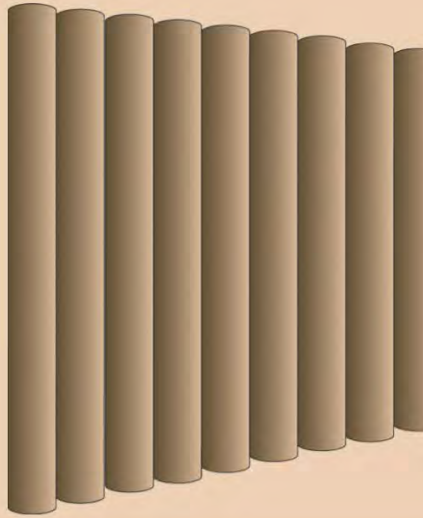


Joseph Lstiburek, Ph.D., P.Eng, ASHRAE Fellow

Building Science

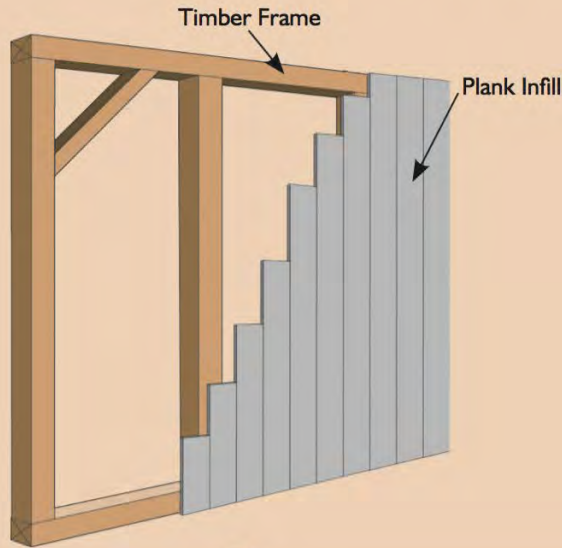
Net Zero Retrofit

One Thousand Years of Evolution: A Timeline



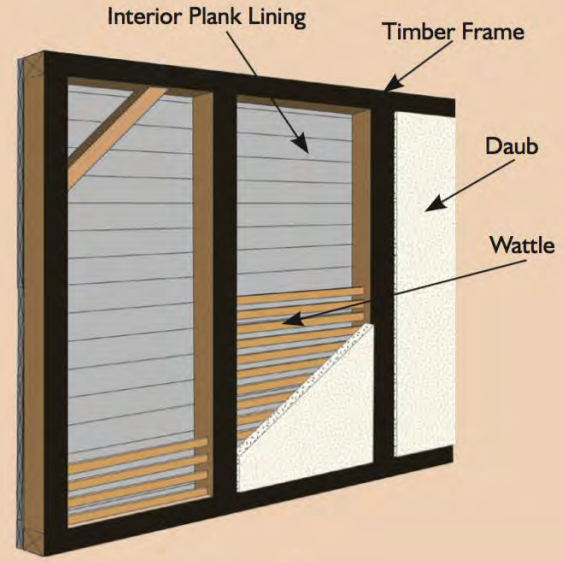
900 C.E.

Palisade wall: Closely spaced posts embedded in the ground.



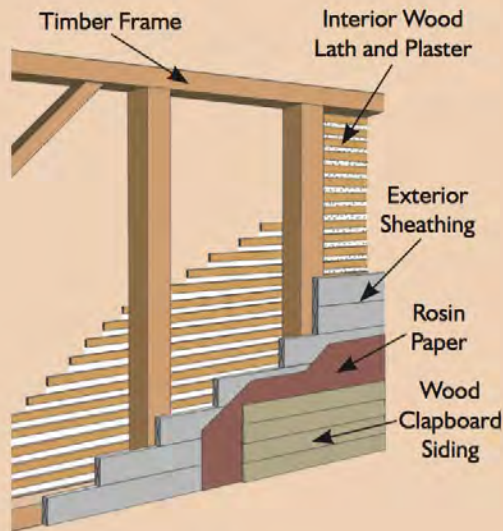
1200

Timber frame: Stave construction, timber four-sided frame with vertical exterior weatherboards.



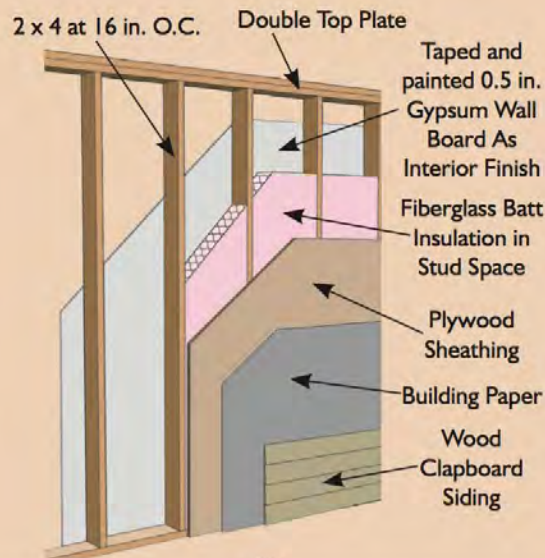
1600

Wattle and daub: Tar coated exposed frame with an early pre-evolutionary version of exterior stucco—Neanderthal Stucco. Board sheathing inner lining.



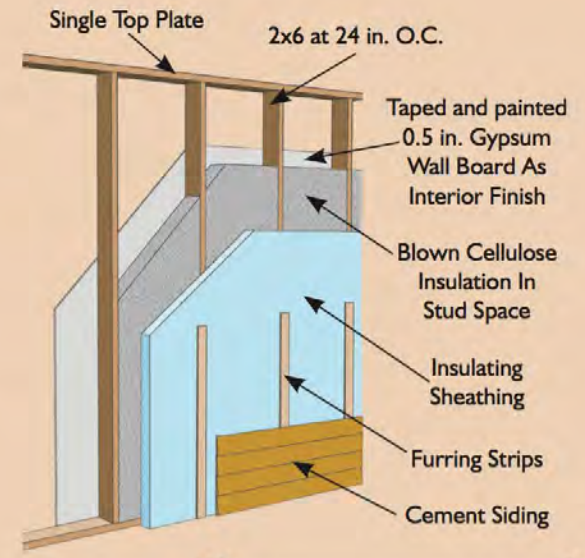
1900

Clapboard timber frame: Typical 1900 New England timber frame with plaster and lath interior lining and exterior board sheathing, rosin paper and clapboards.



1950

Platform frame: Typical 1950 American wood frame assembly with plywood sheathing and an interior gypsum board lining.



1990

Advanced frame: Insulating sheathing over 2x6 advanced frame.











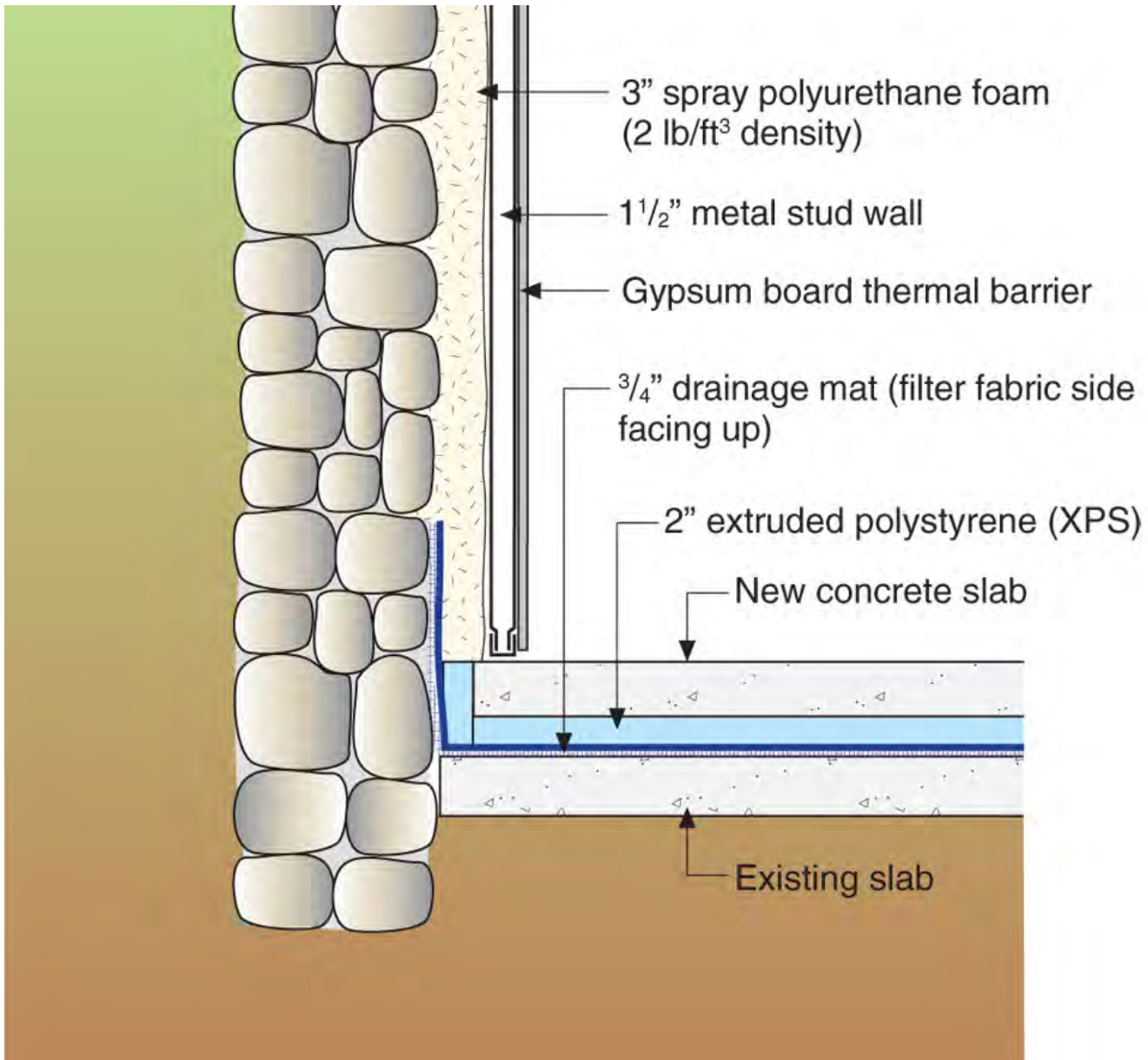


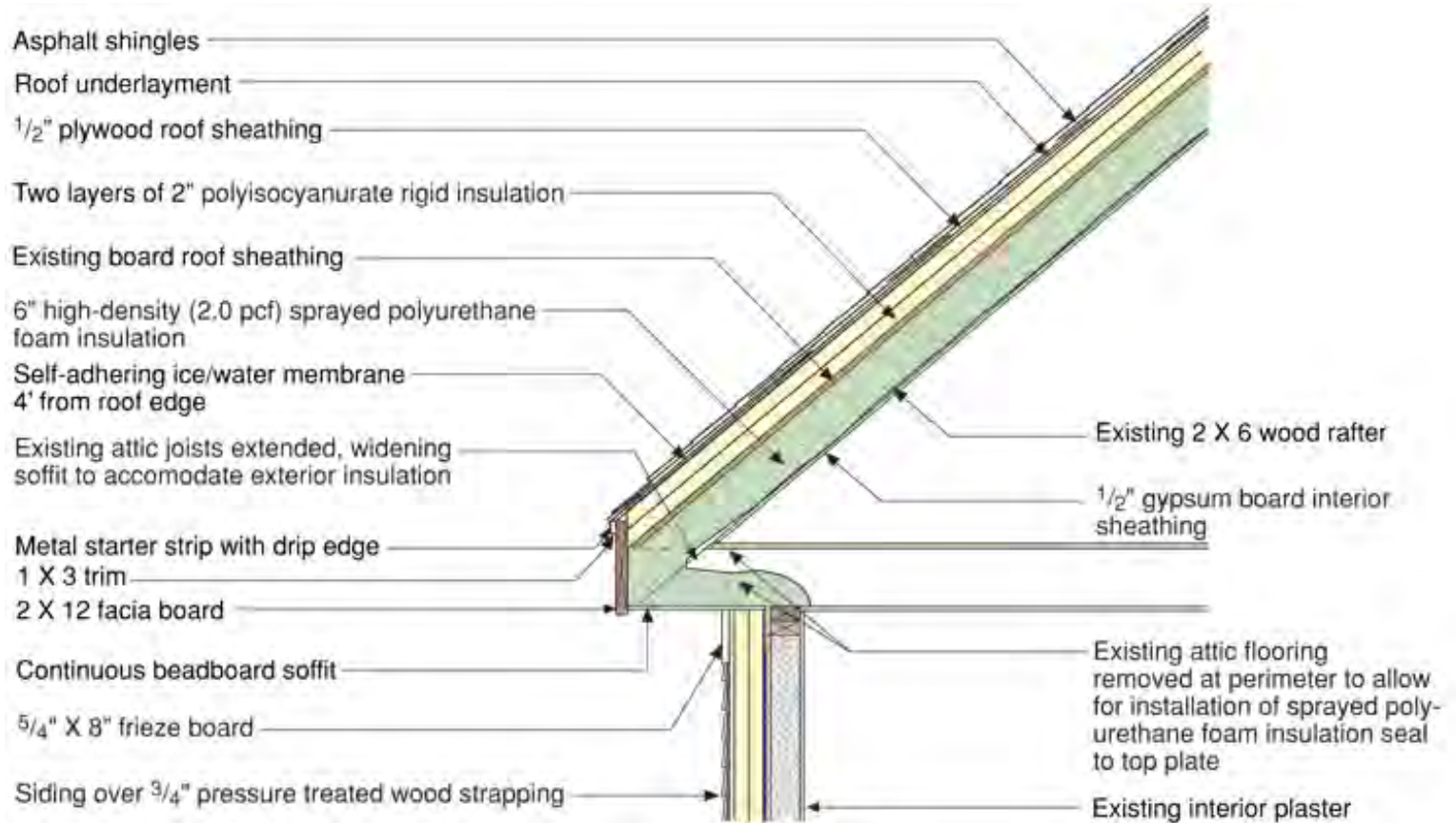
































































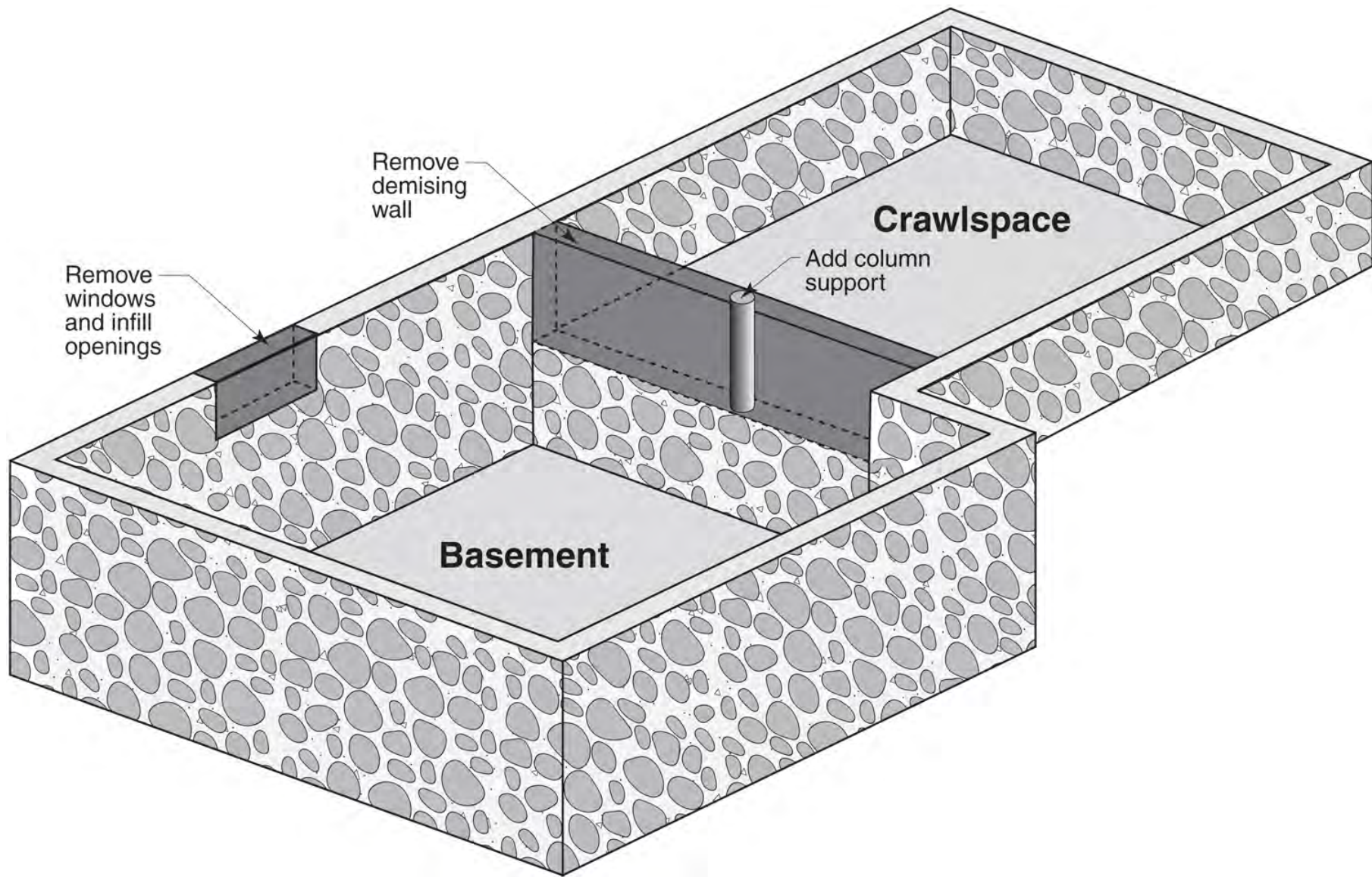




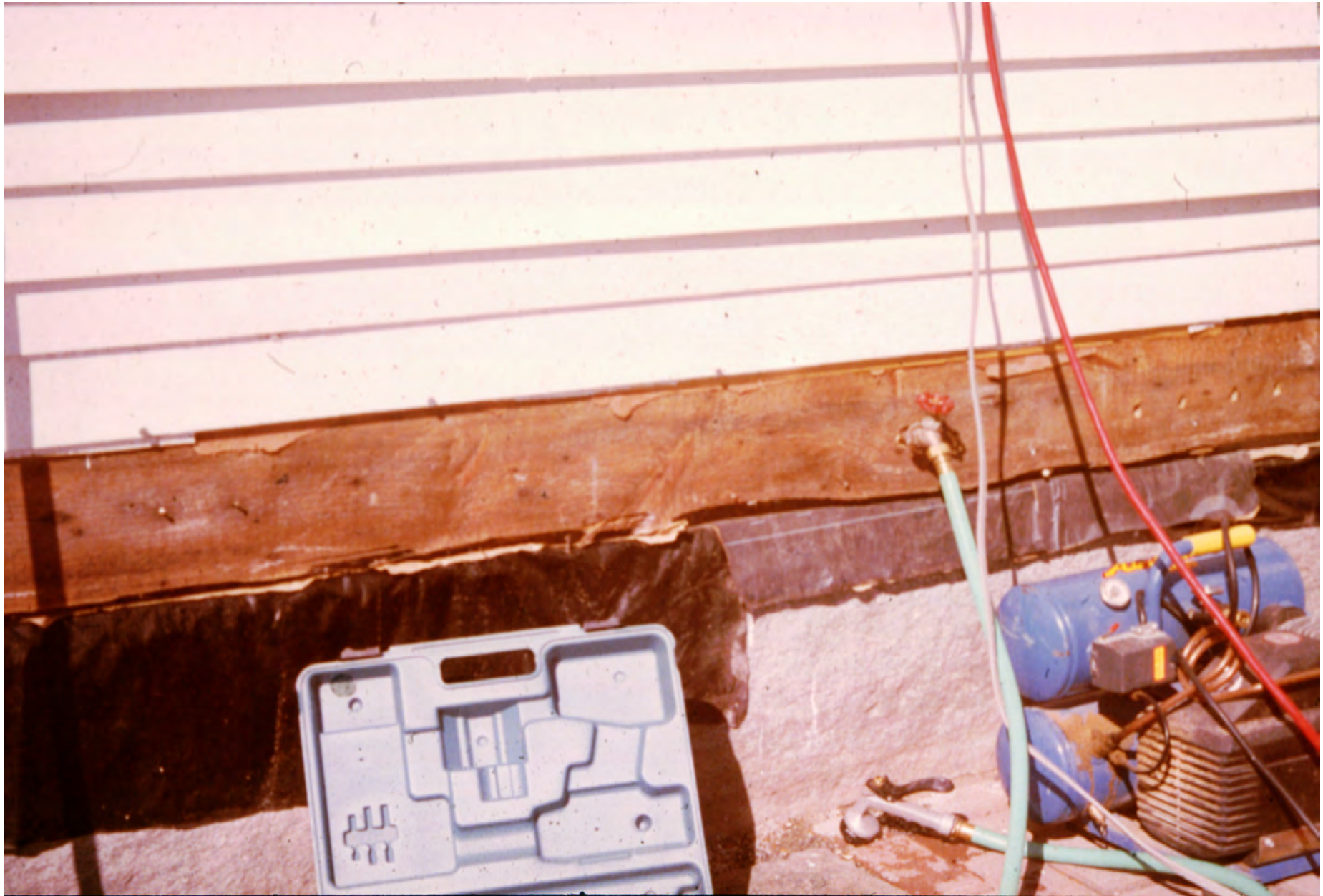










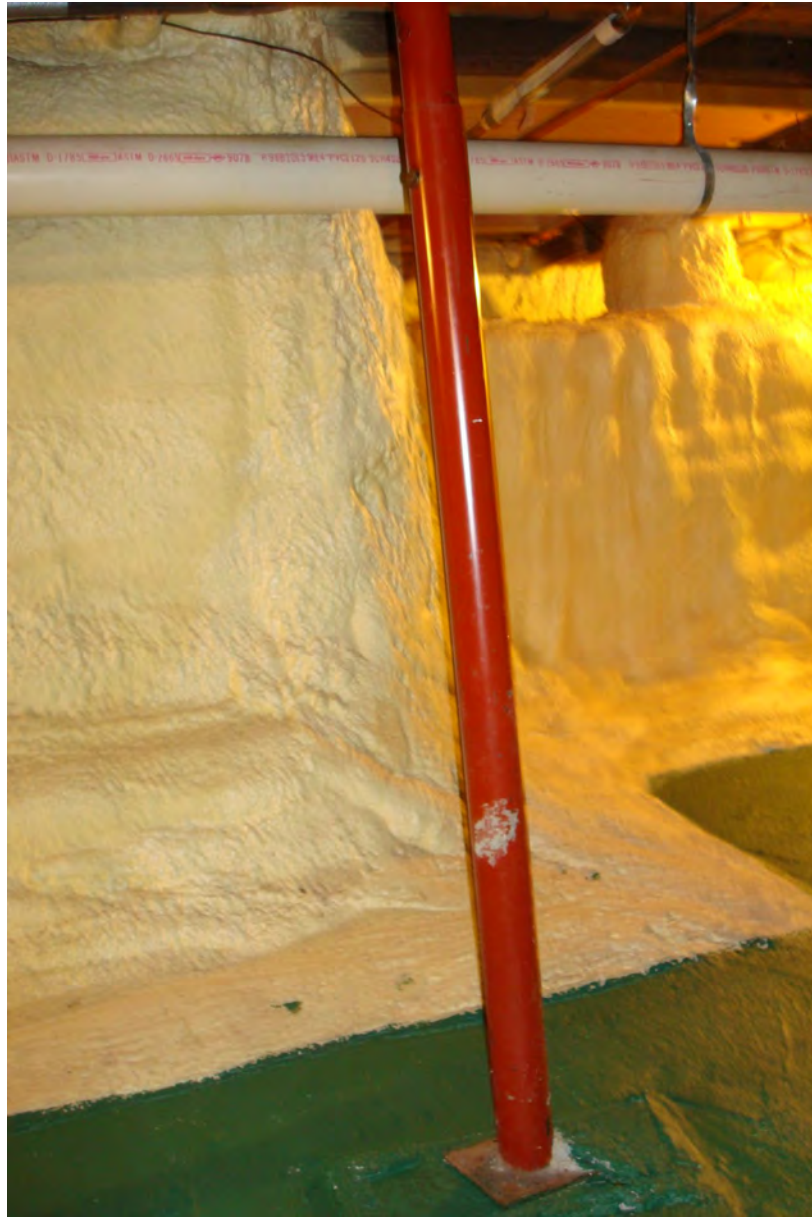












































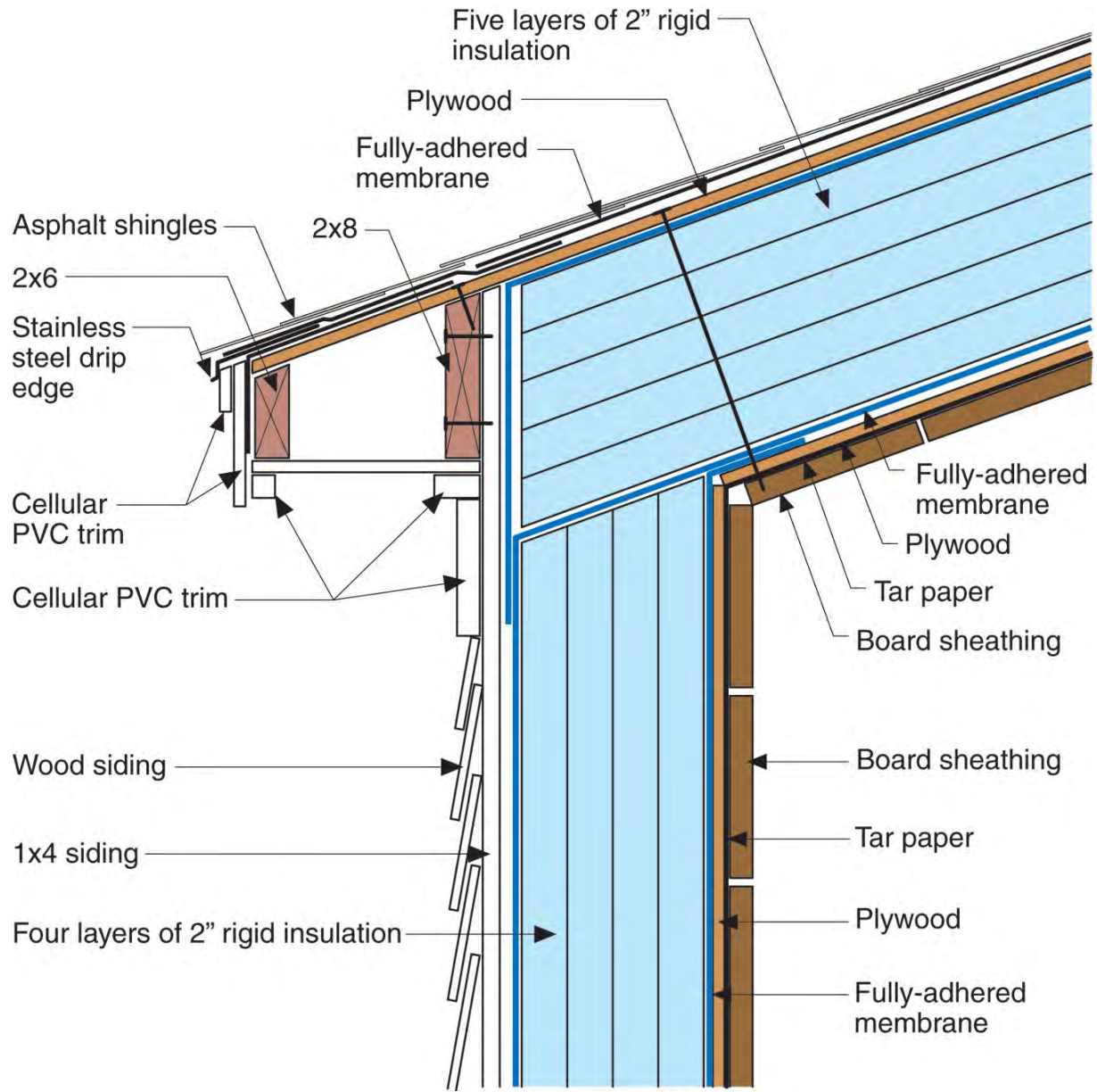


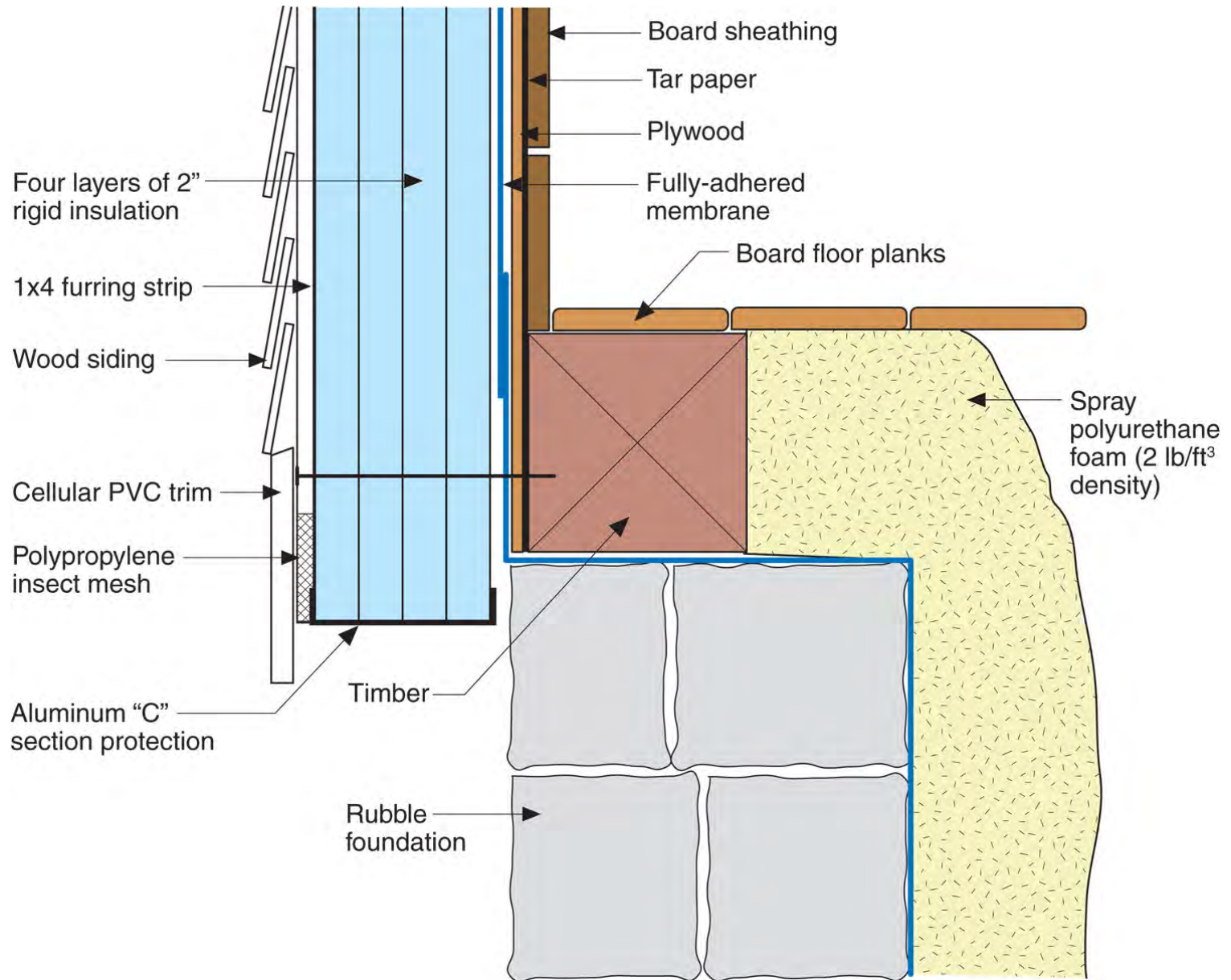


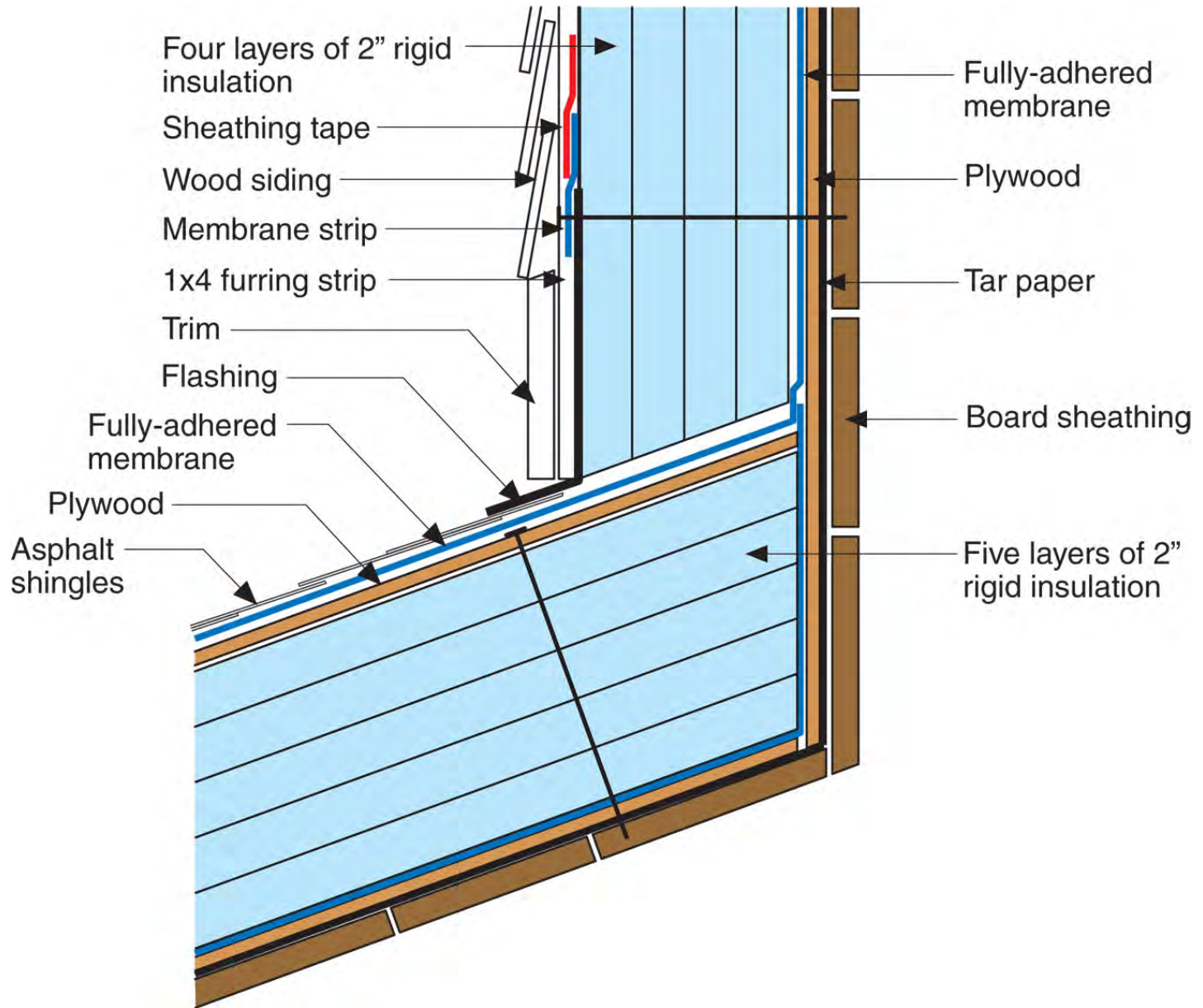






































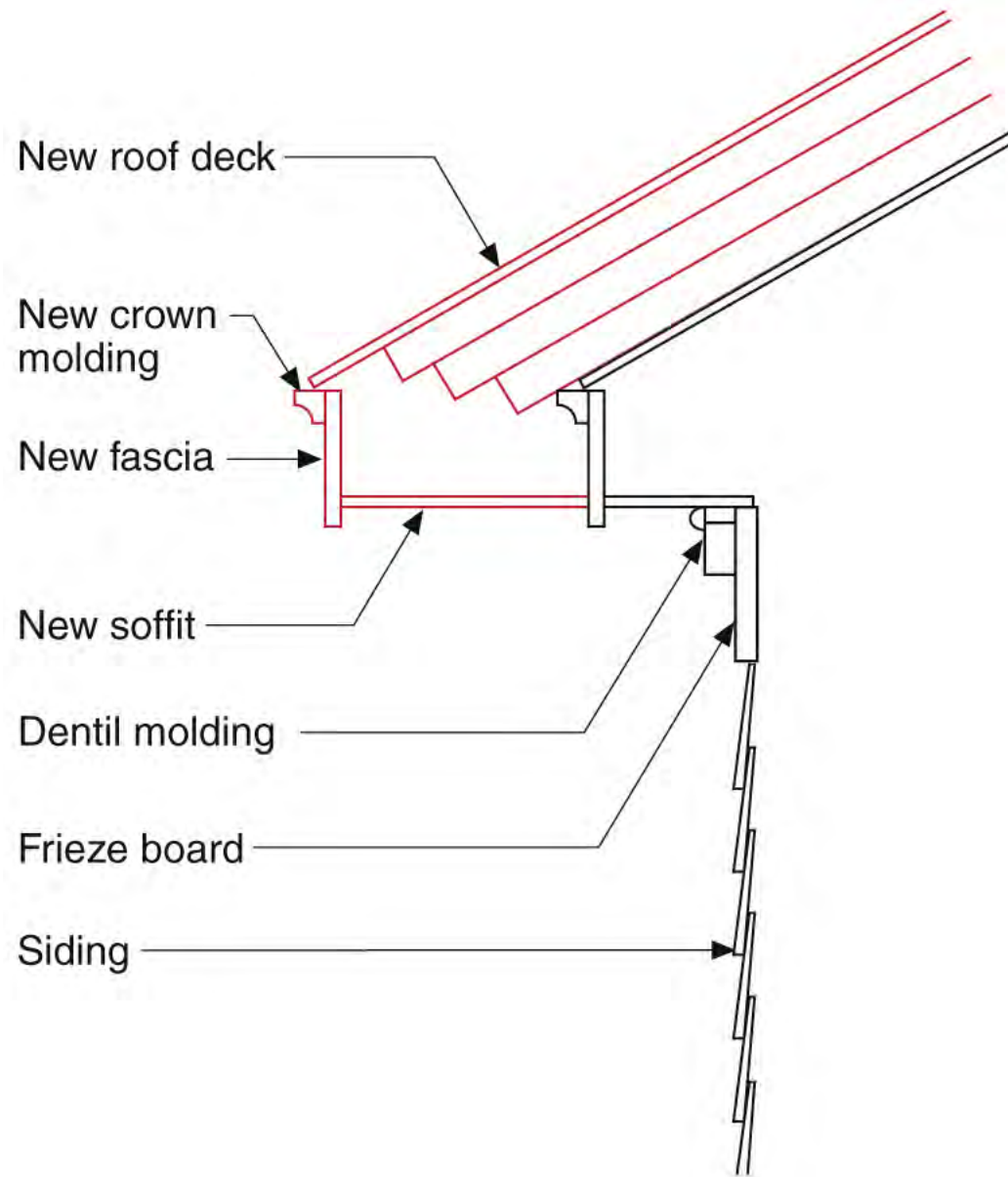


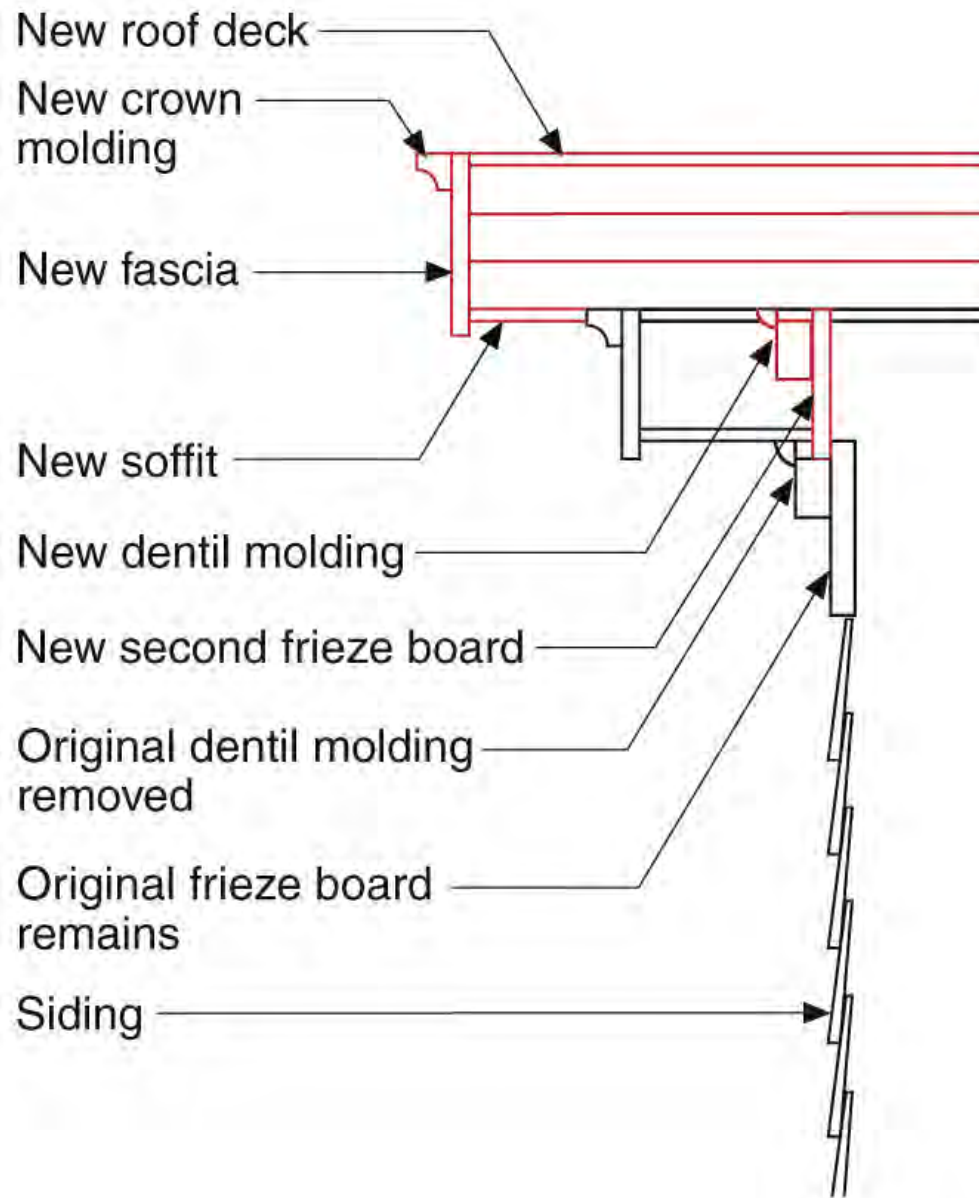
































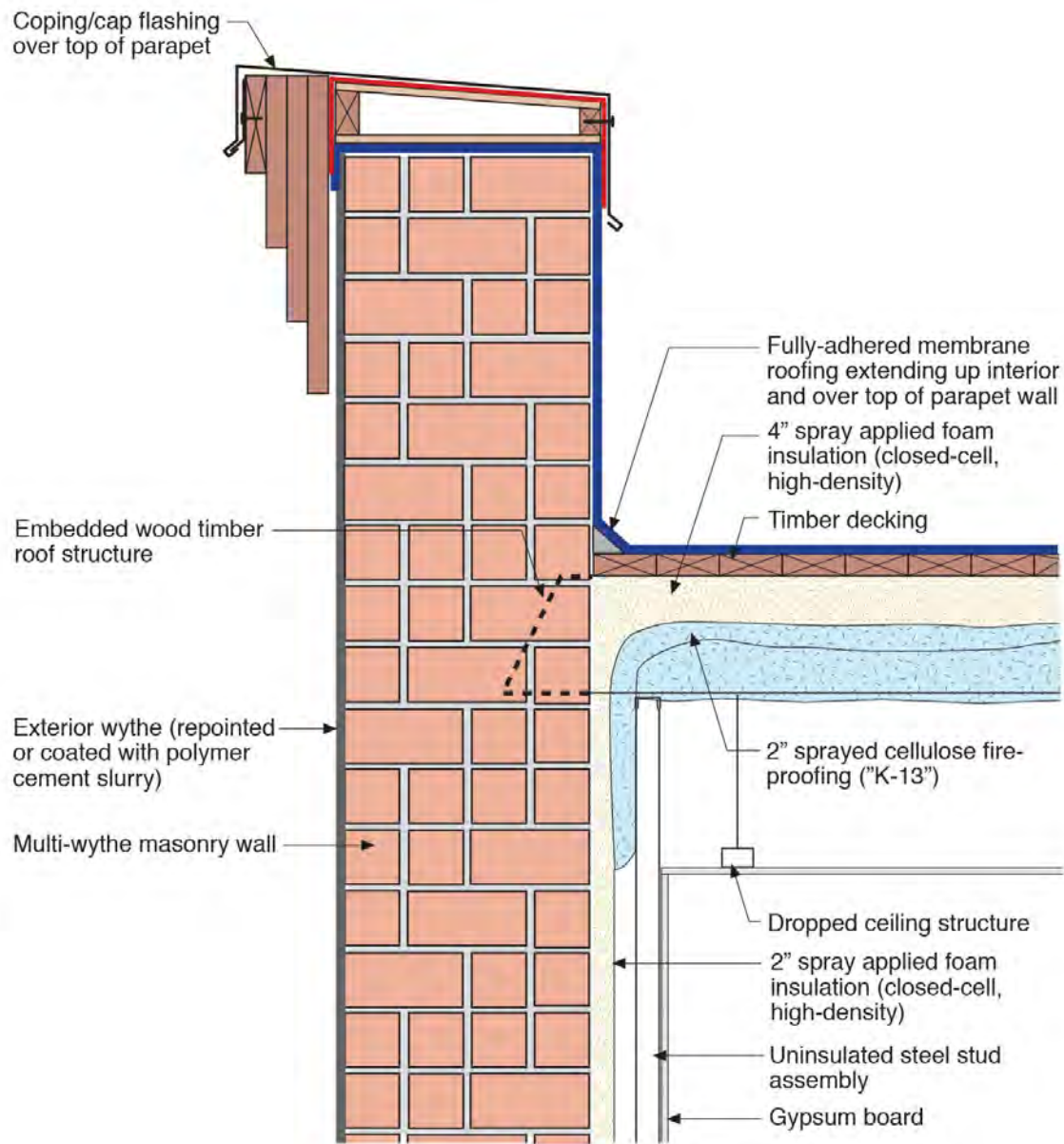






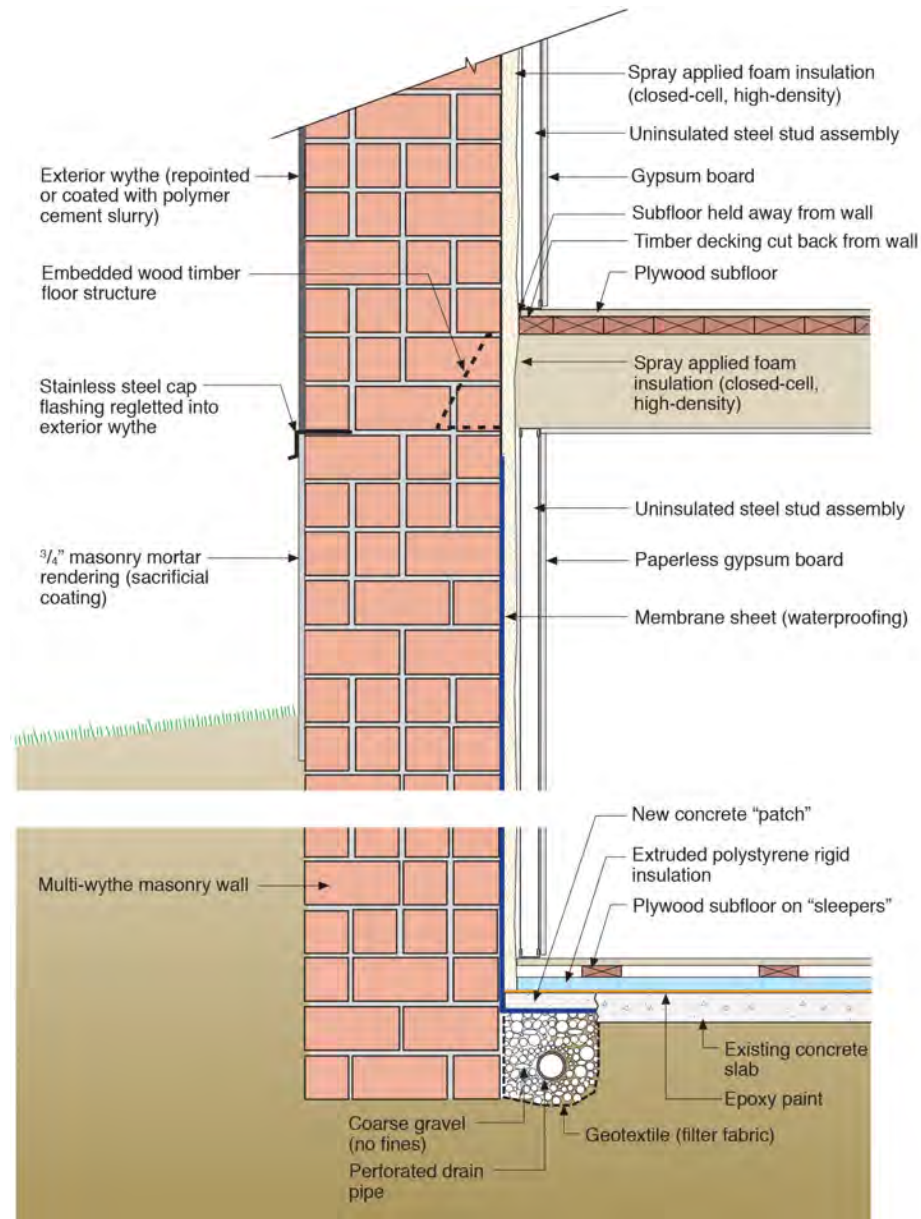


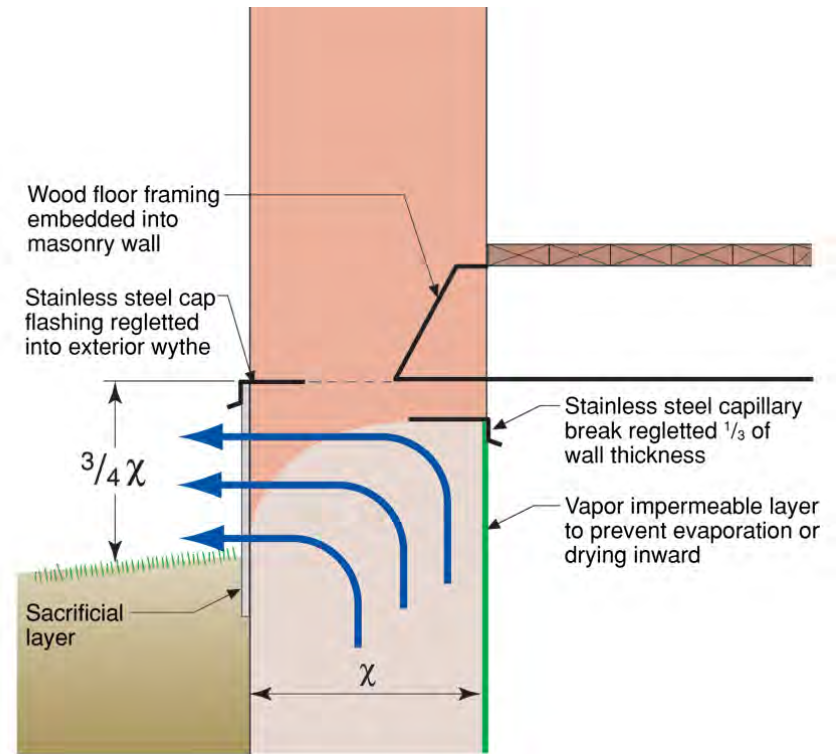
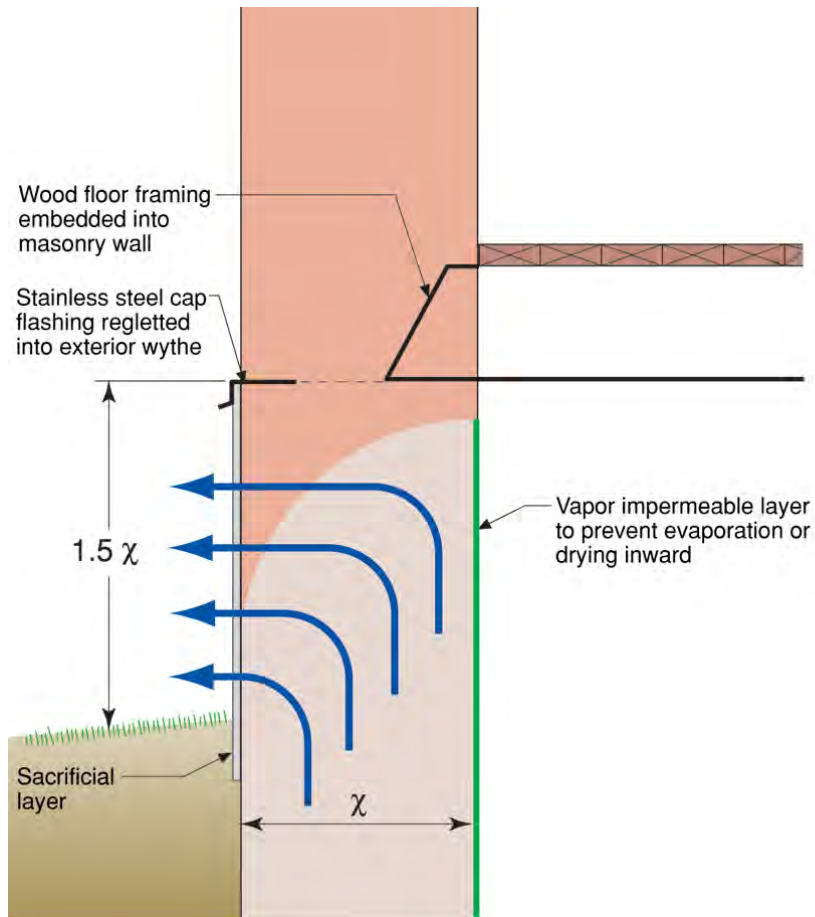


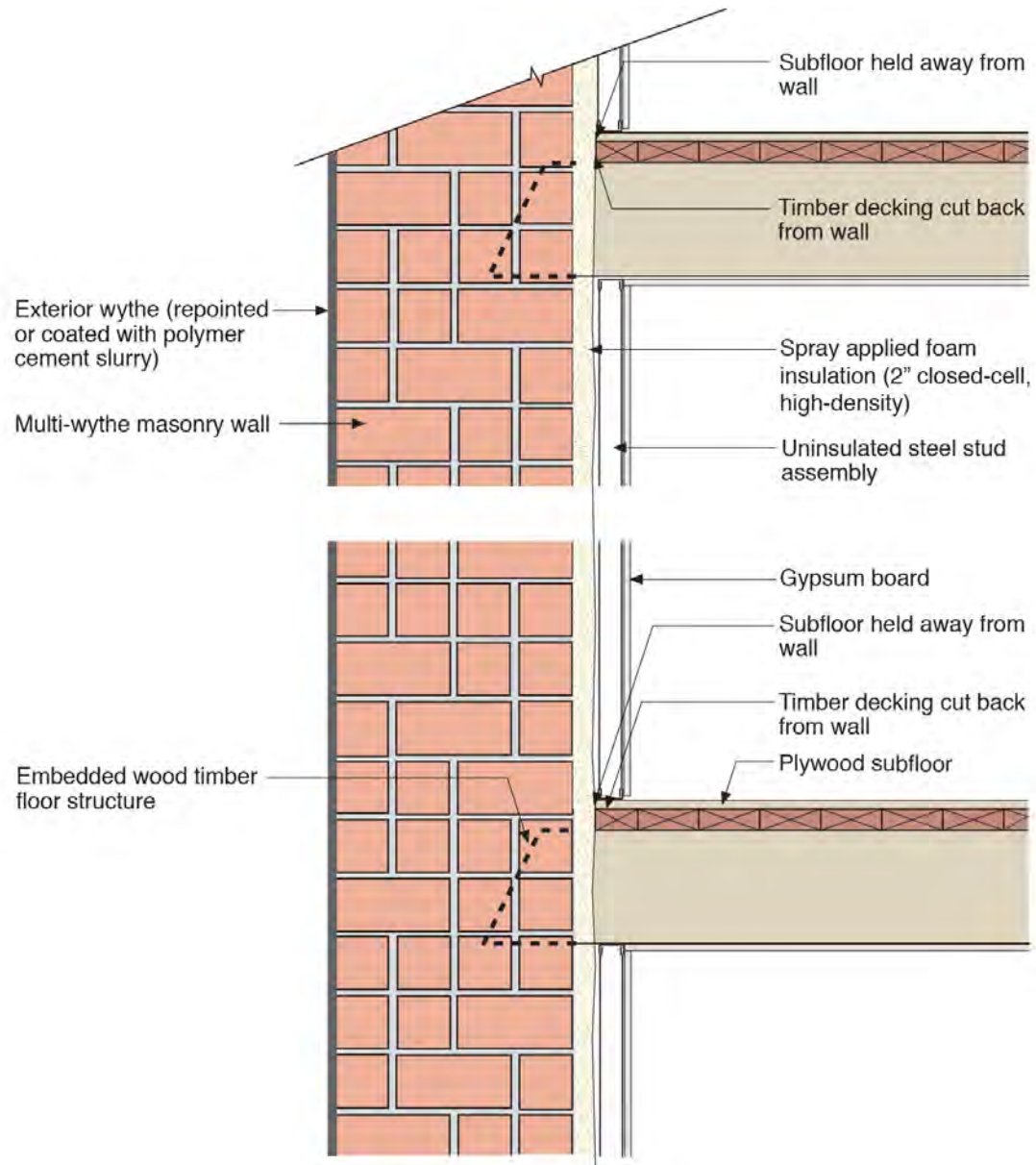




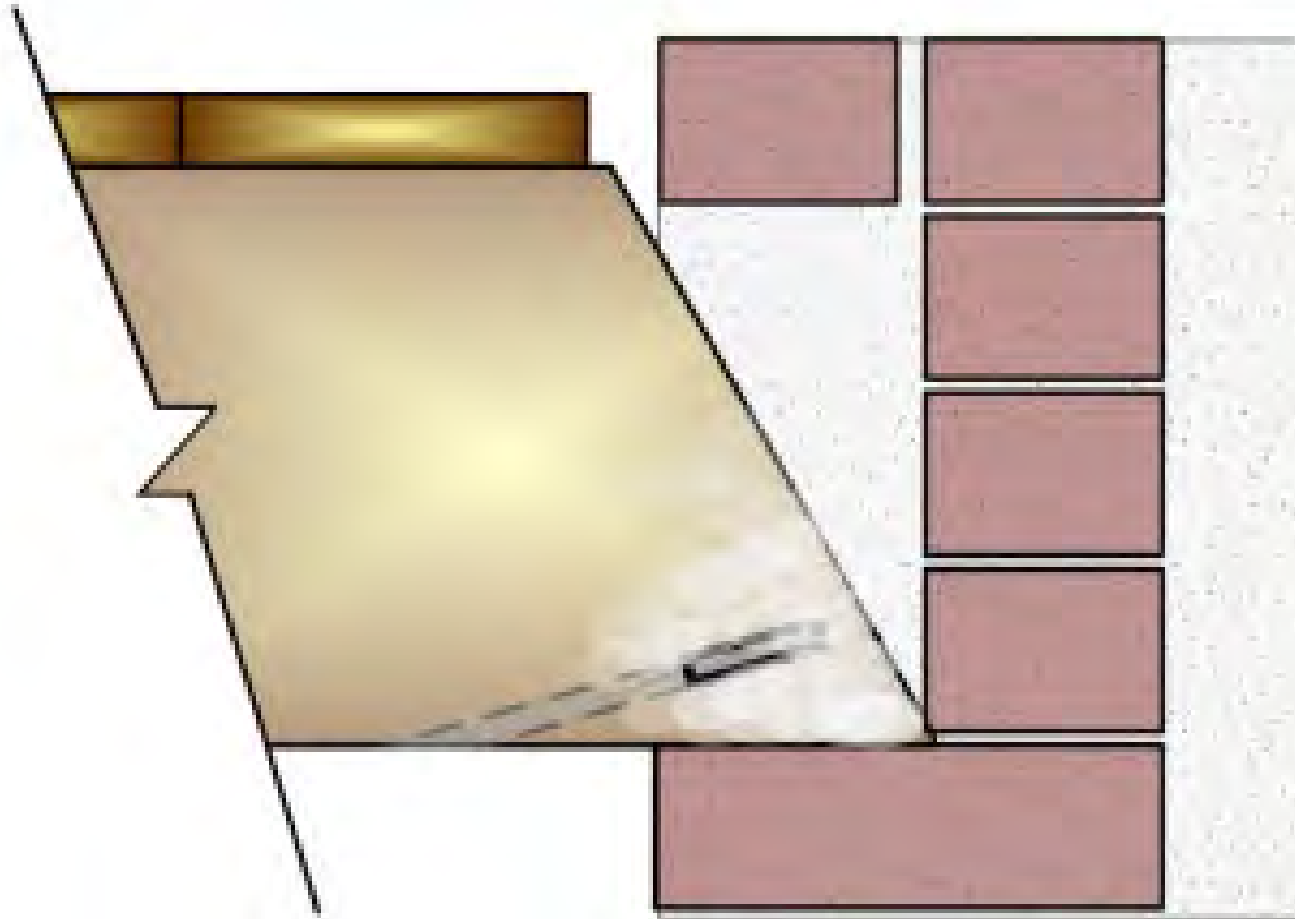


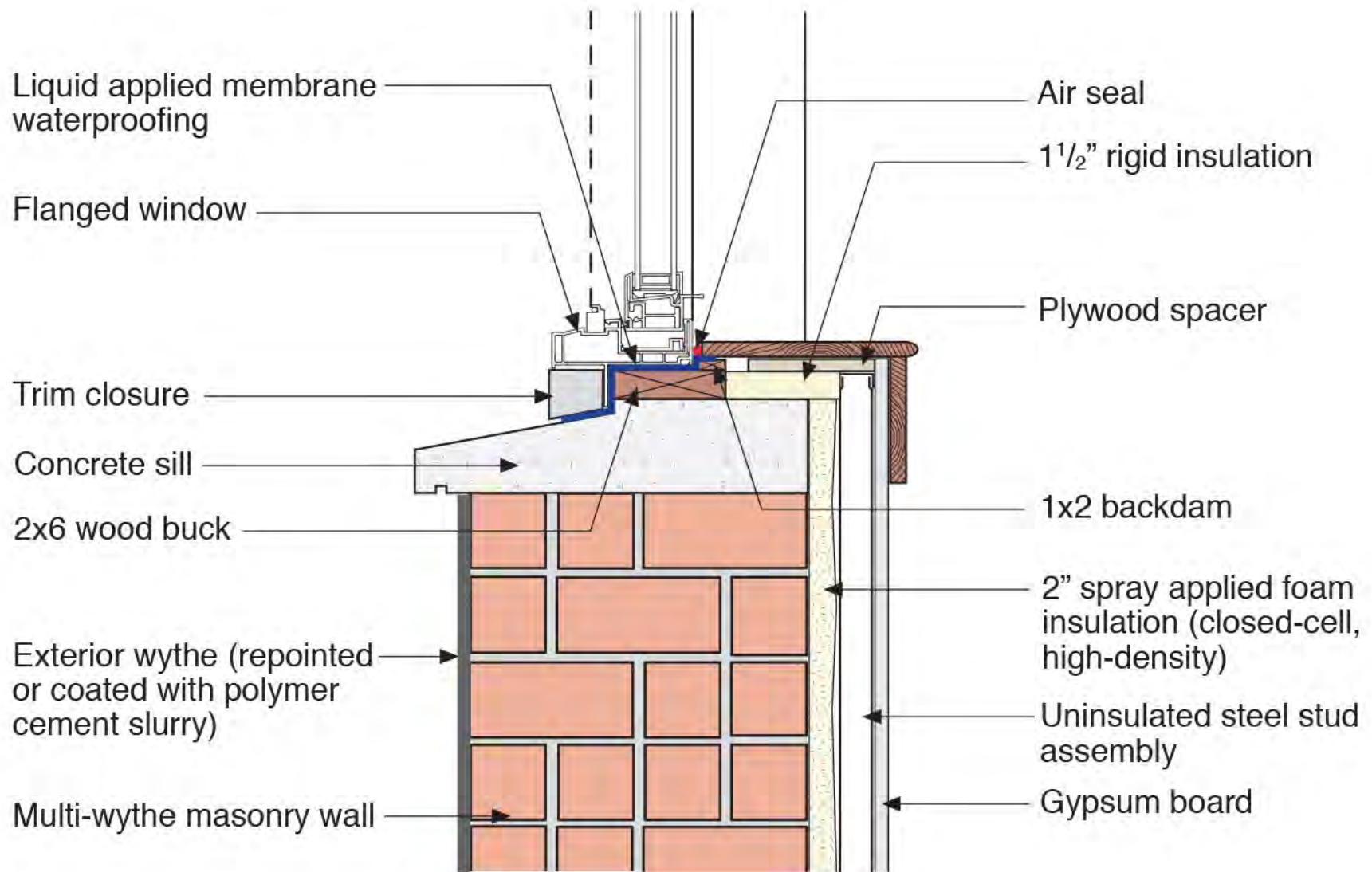






































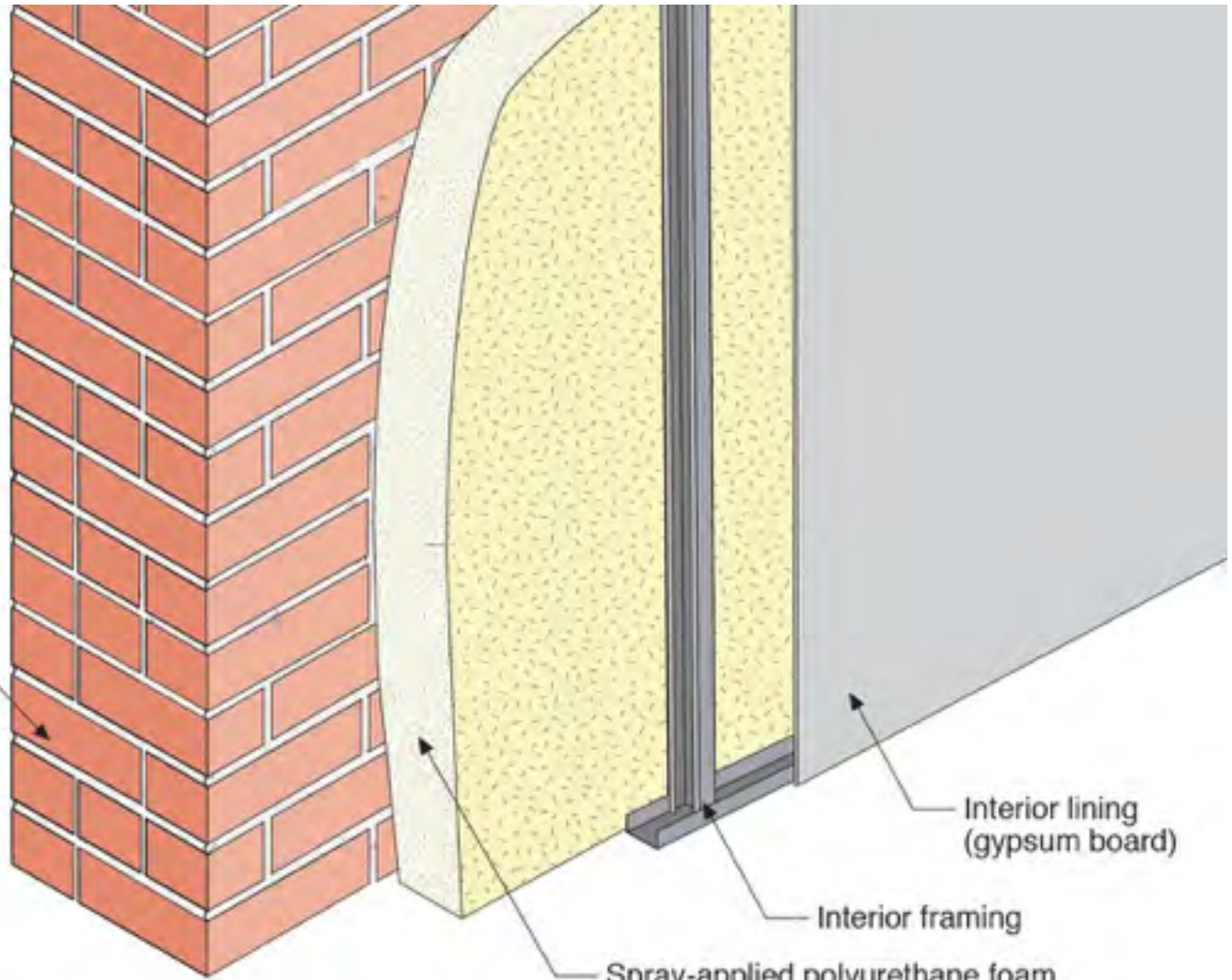








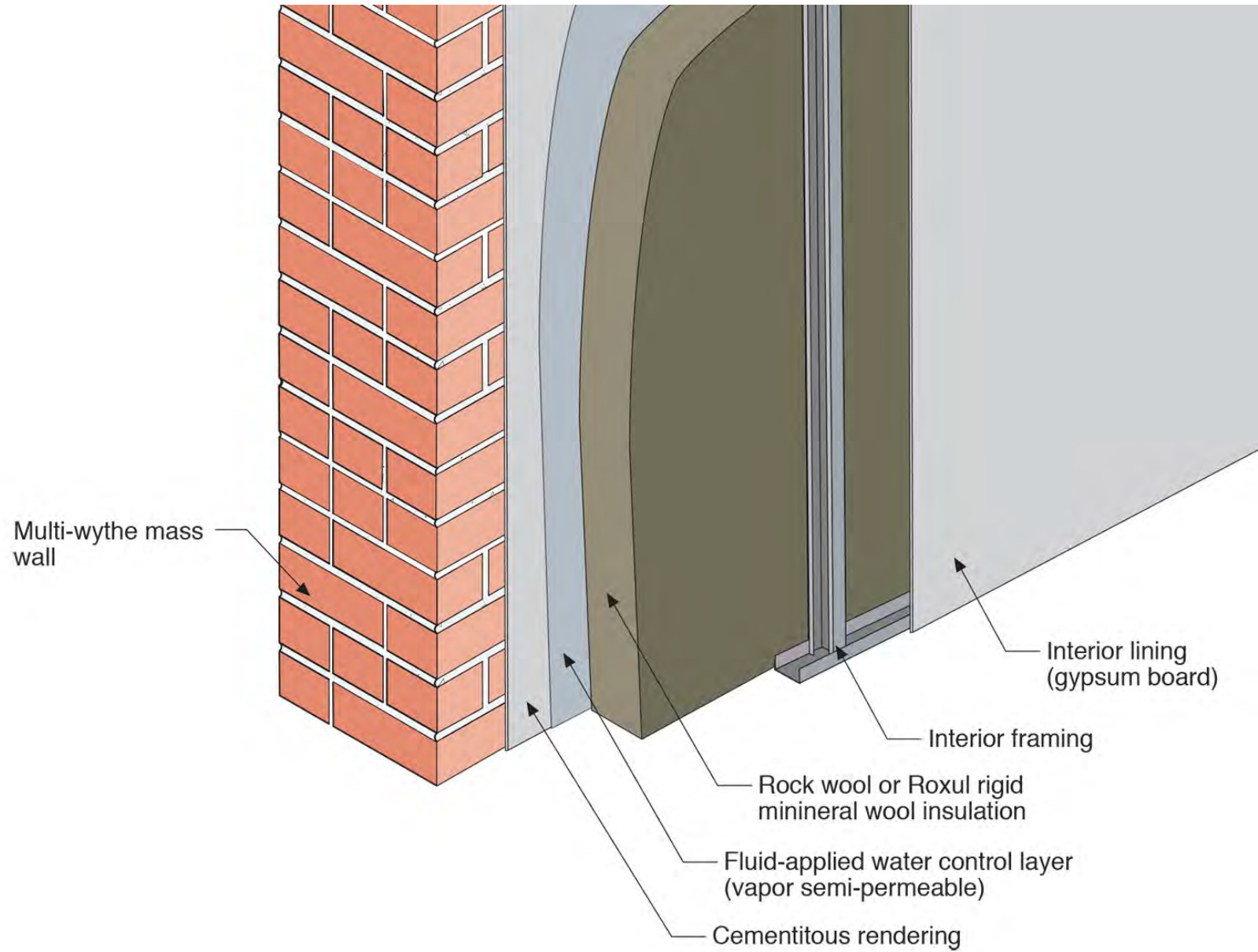
Multi-wythe mass wall

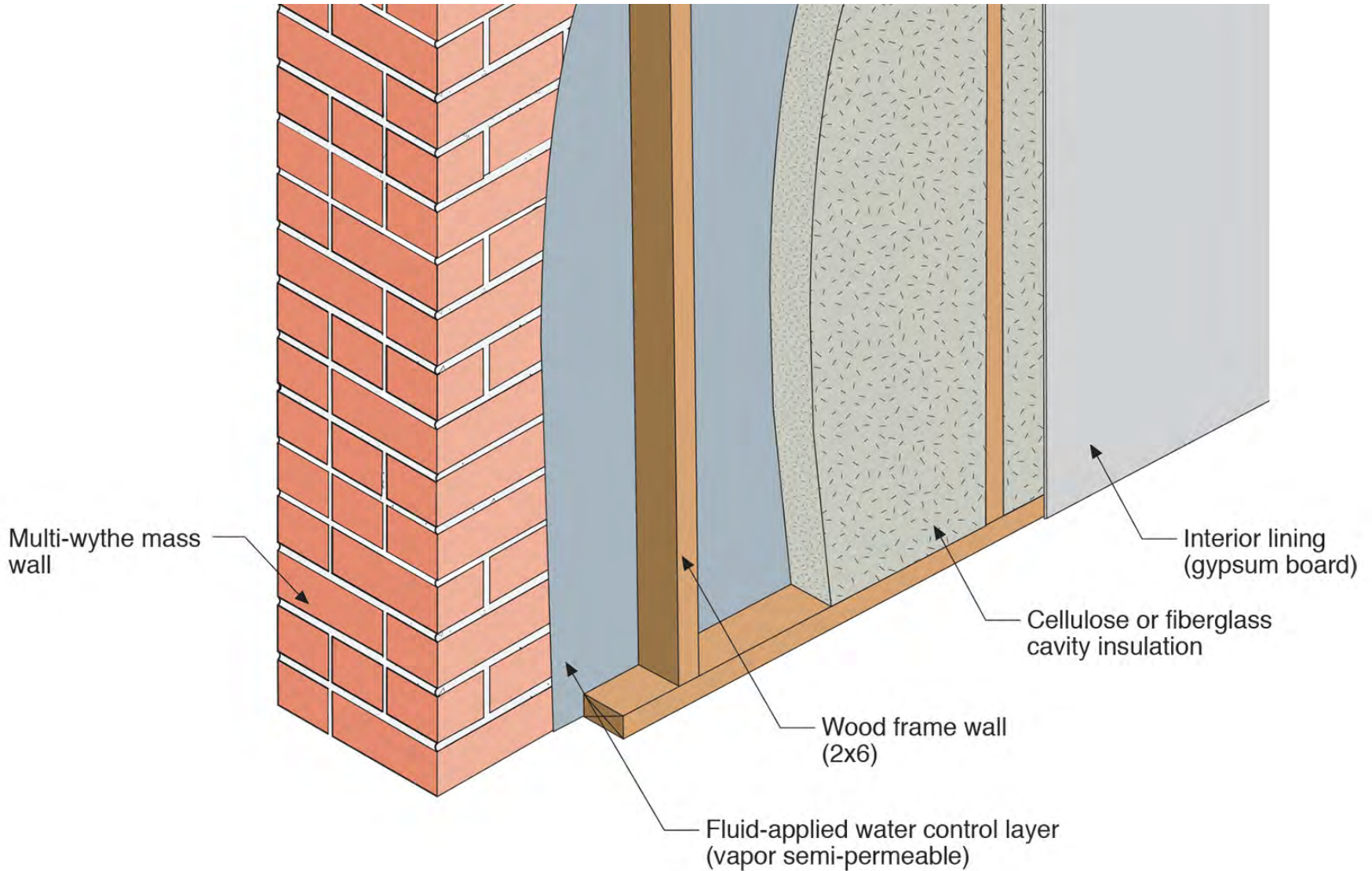


Interior lining
(gypsum board)

Interior framing

Spray-applied polyurethane foam
(2 lb/ft³ density)





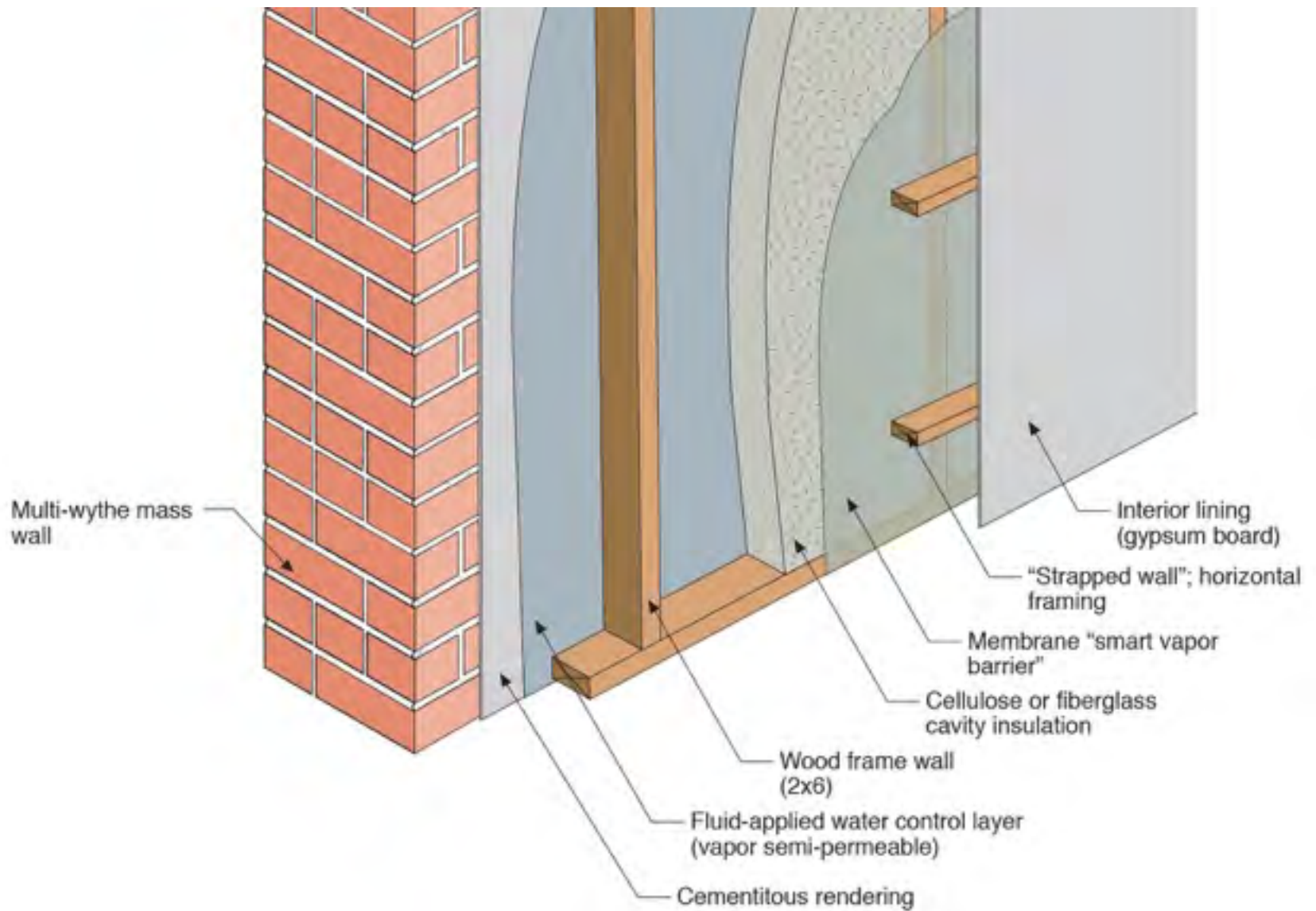
Multi-wythe mass wall

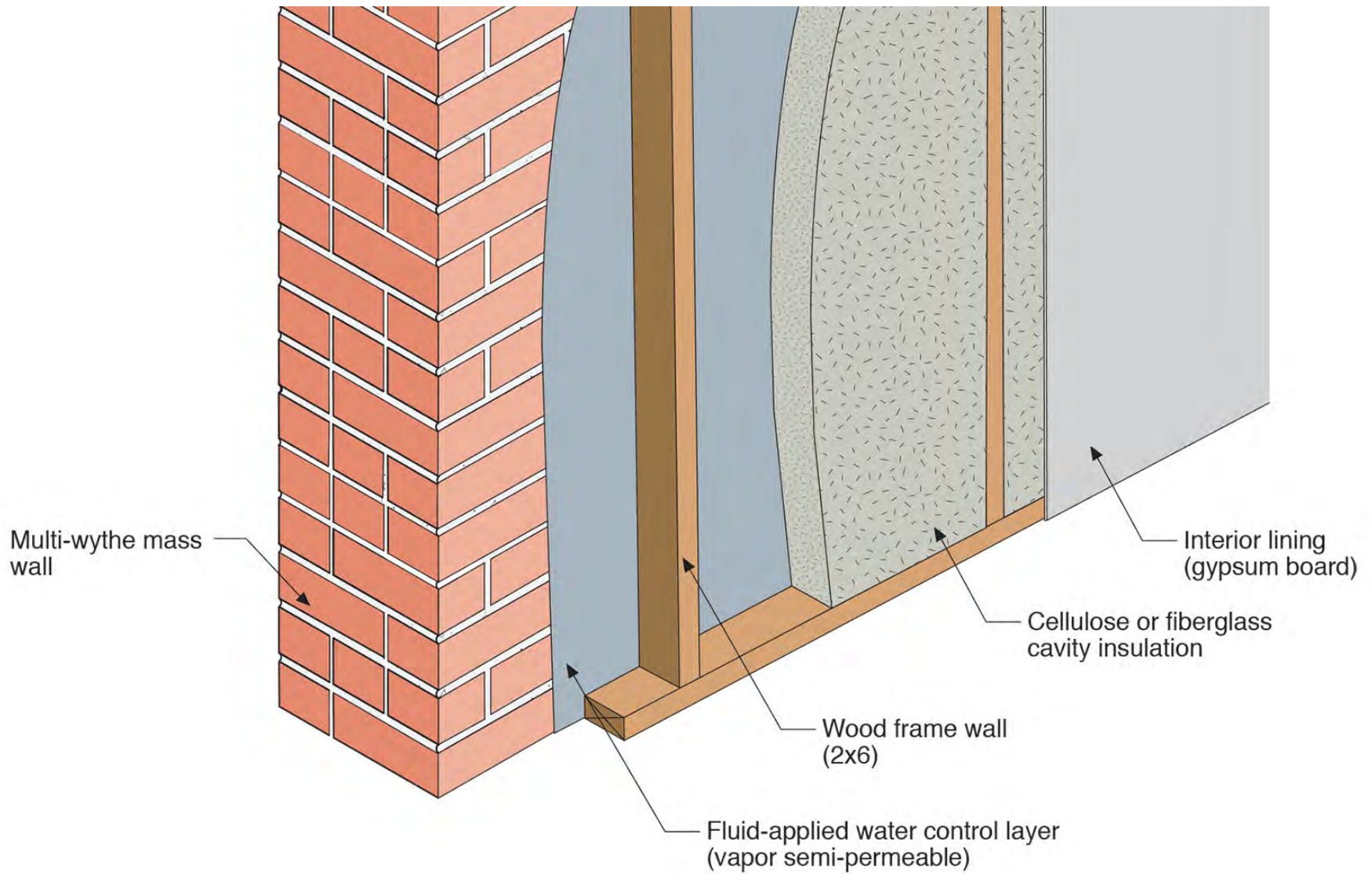
Interior lining (gypsum board)

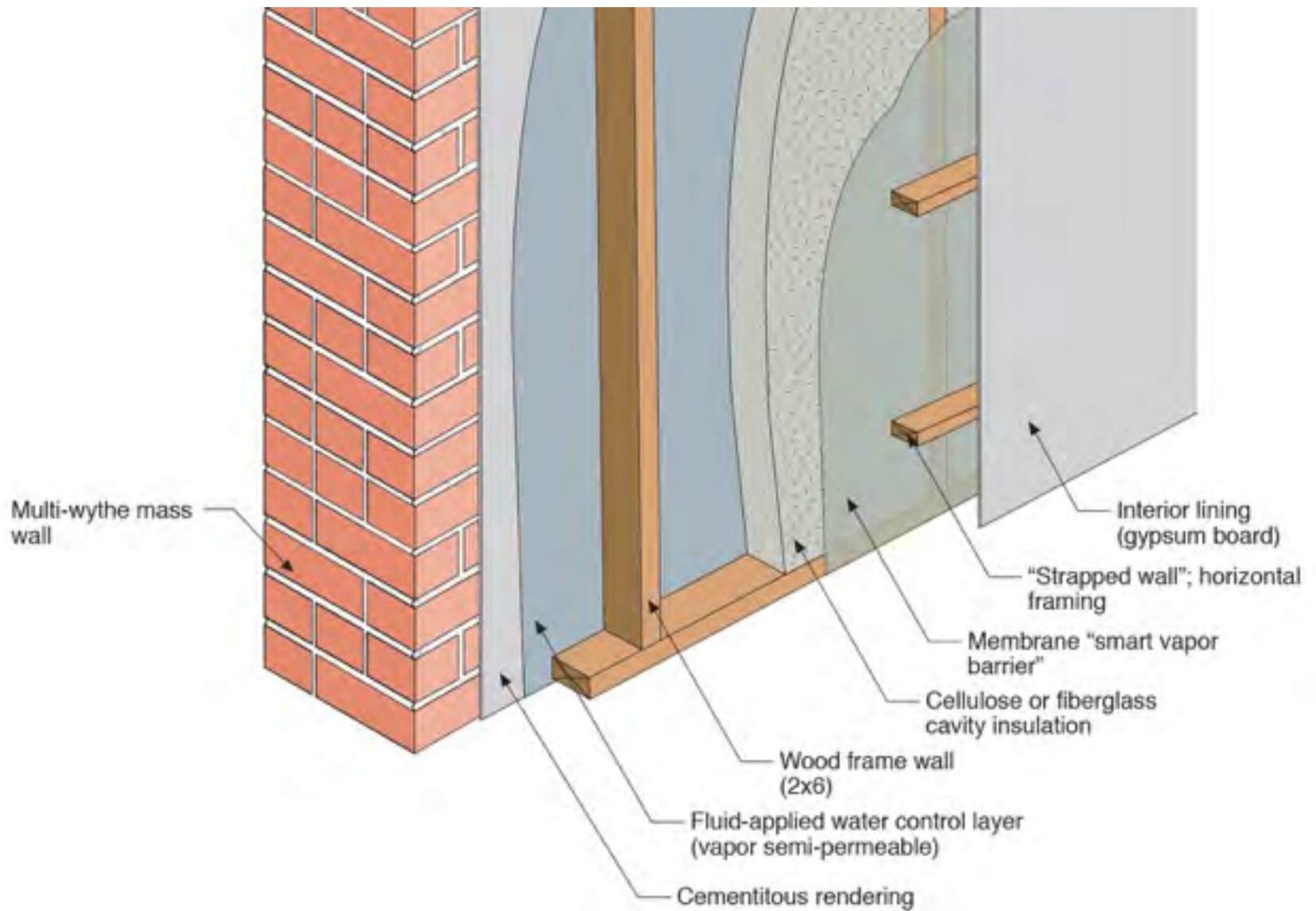
Cellulose or fiberglass cavity insulation

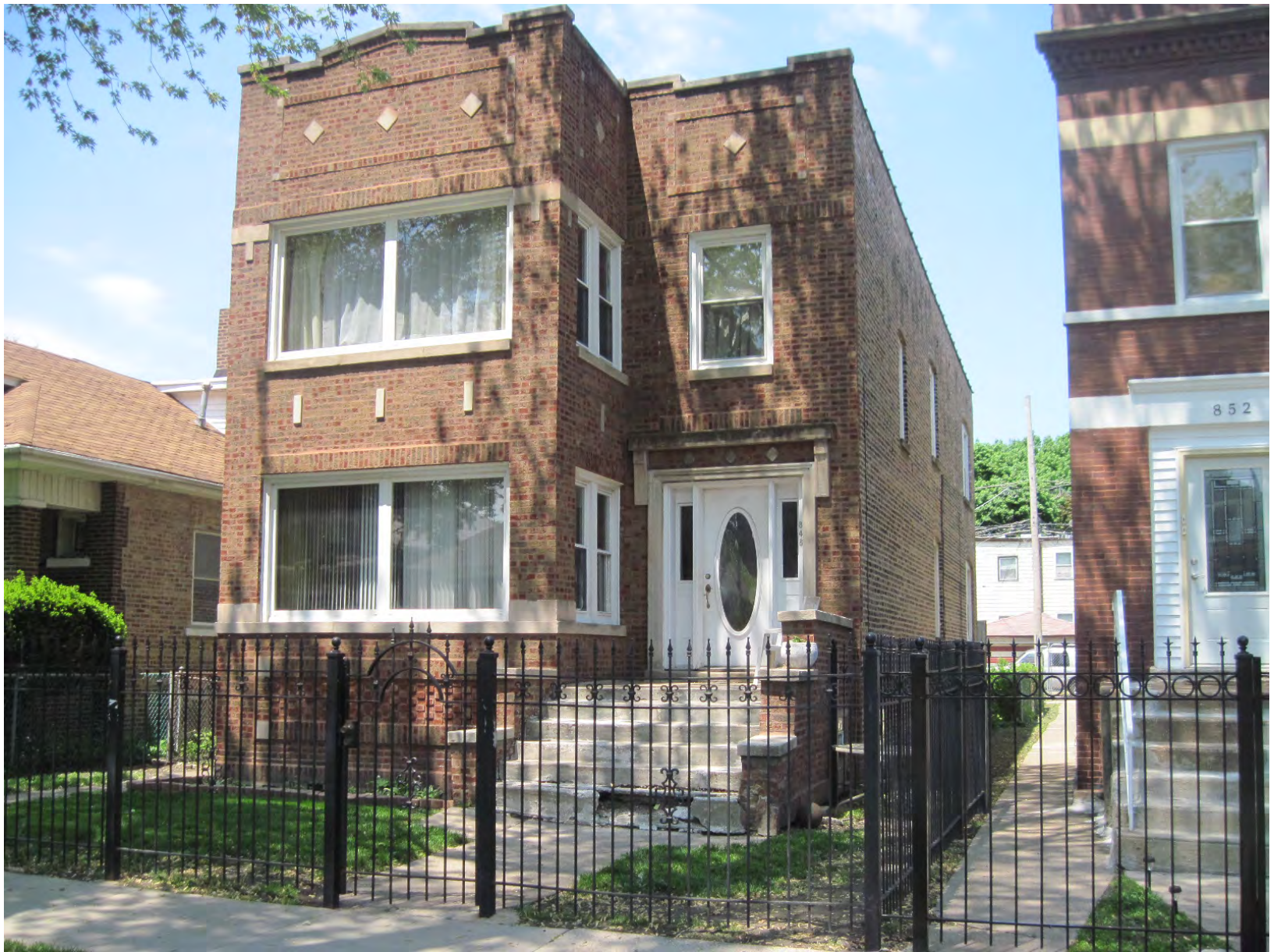
Wood frame wall (2x6)

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











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

