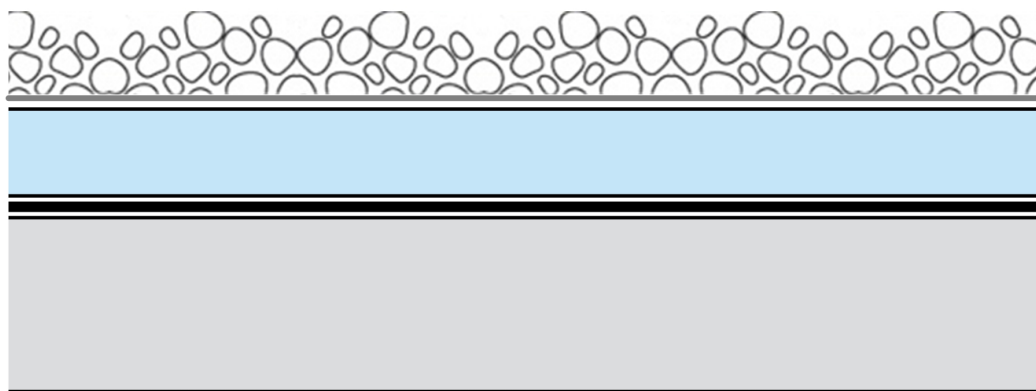


Joseph Lstiburek, Ph.D., P.Eng, ASHRAE Fellow

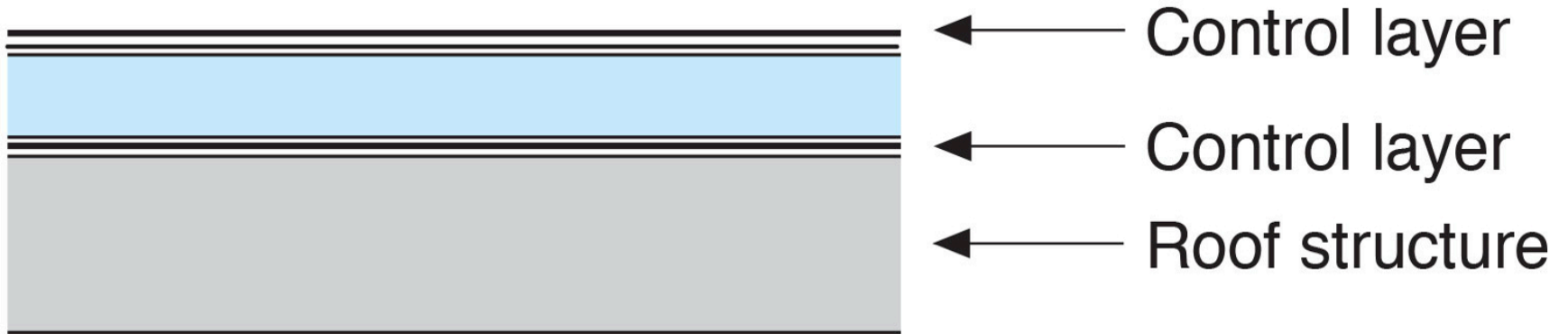
Building Science

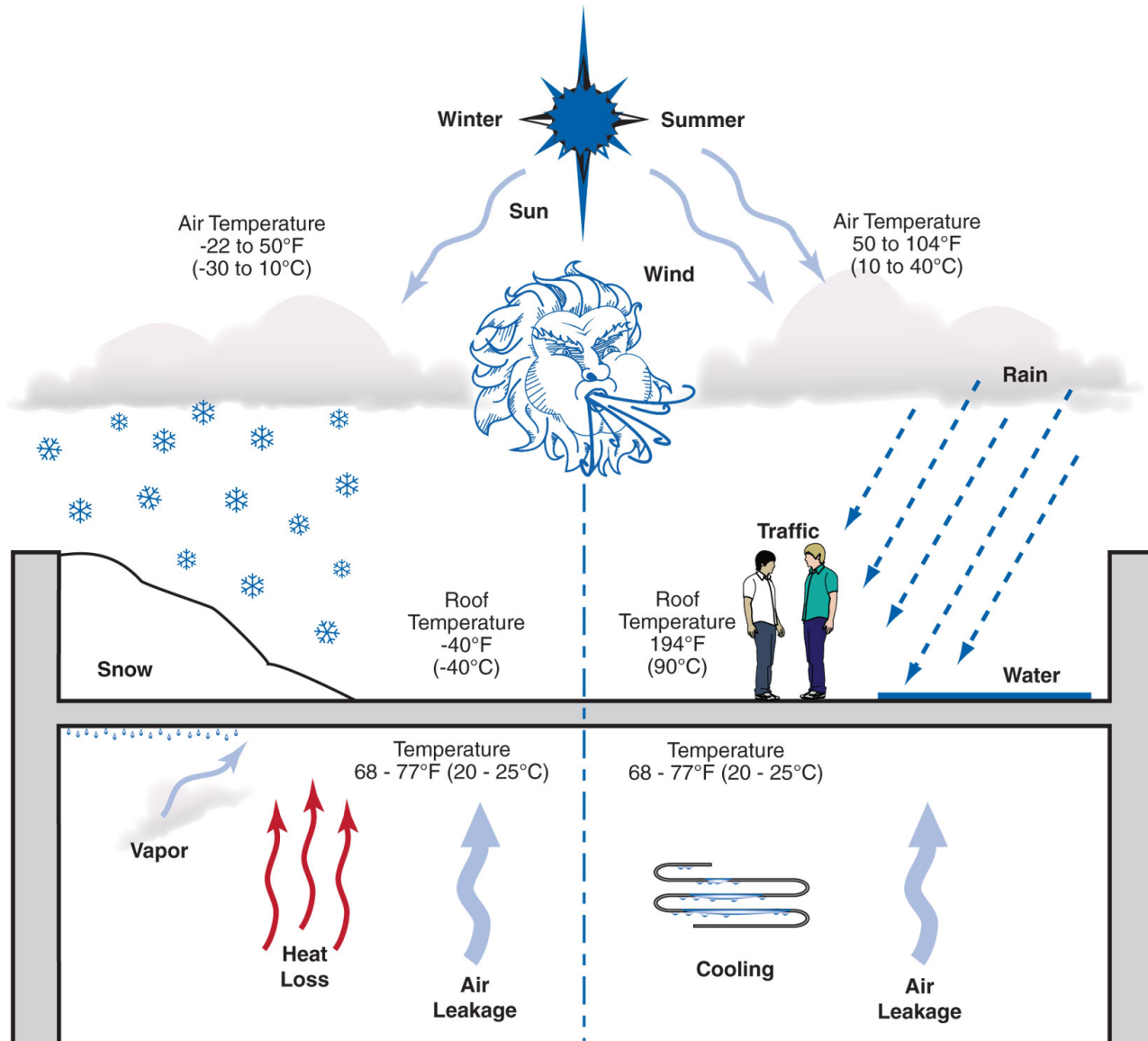
Adventures In Building Science

www.buildingscience.com

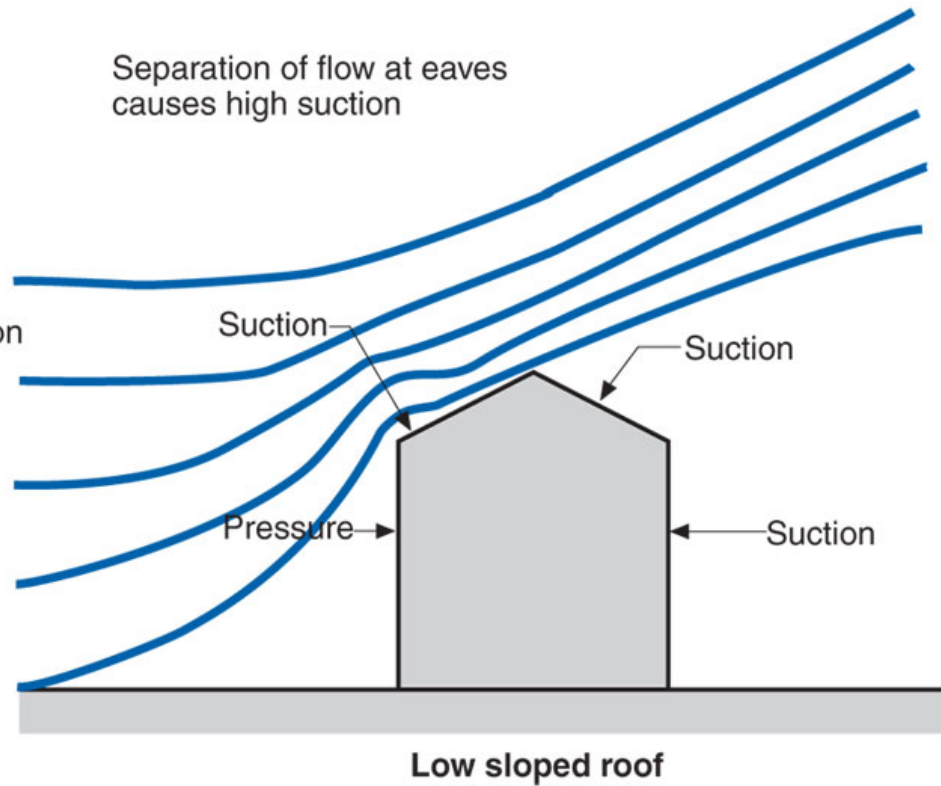
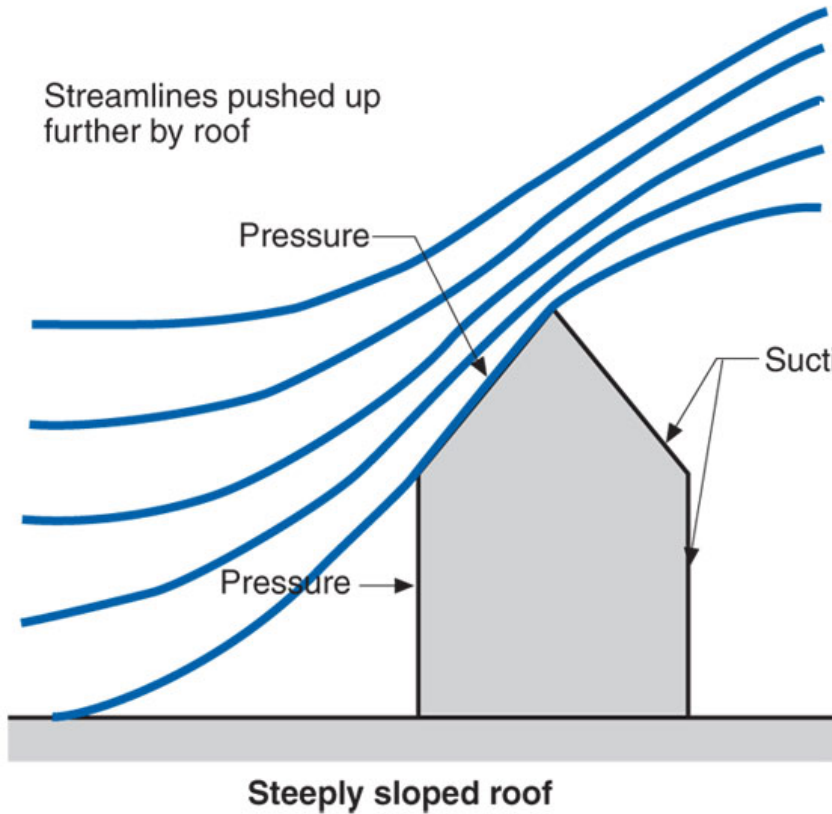


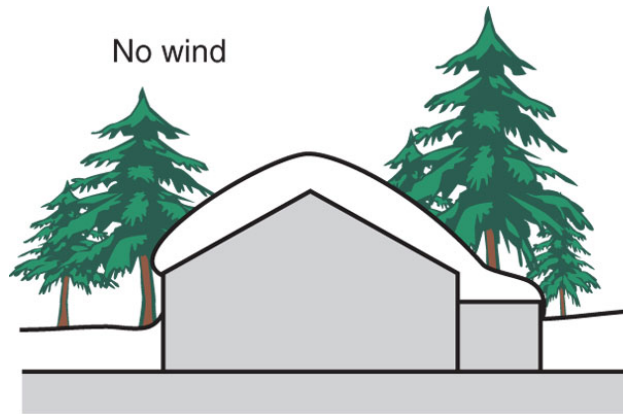
- ← Ballast
- ← Filter fabric
- ← Control layers
- ← Roof structure



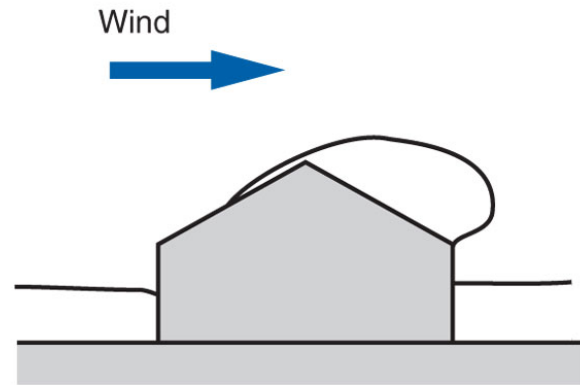


Adapted from Baker, M.; *Roofs*, 1980;
 Courtesy National Research Council of Canada

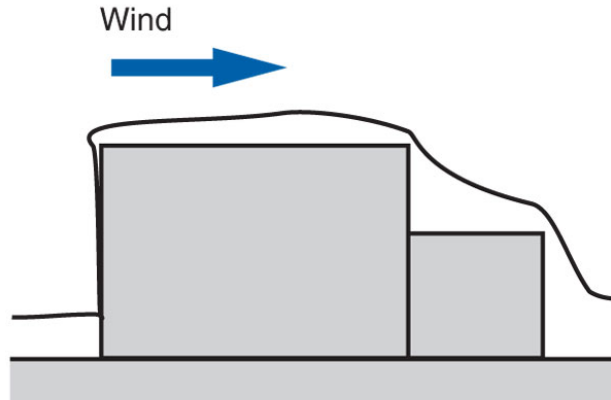




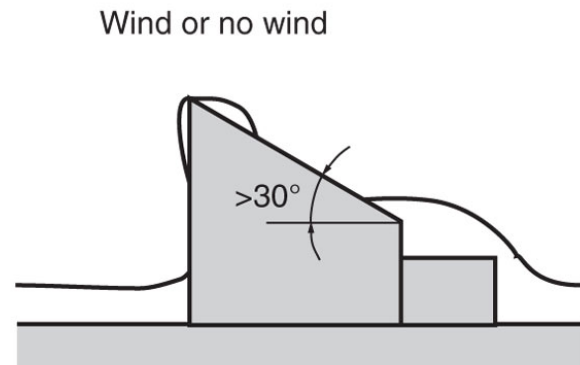
Effect of shelter



Unbalanced load

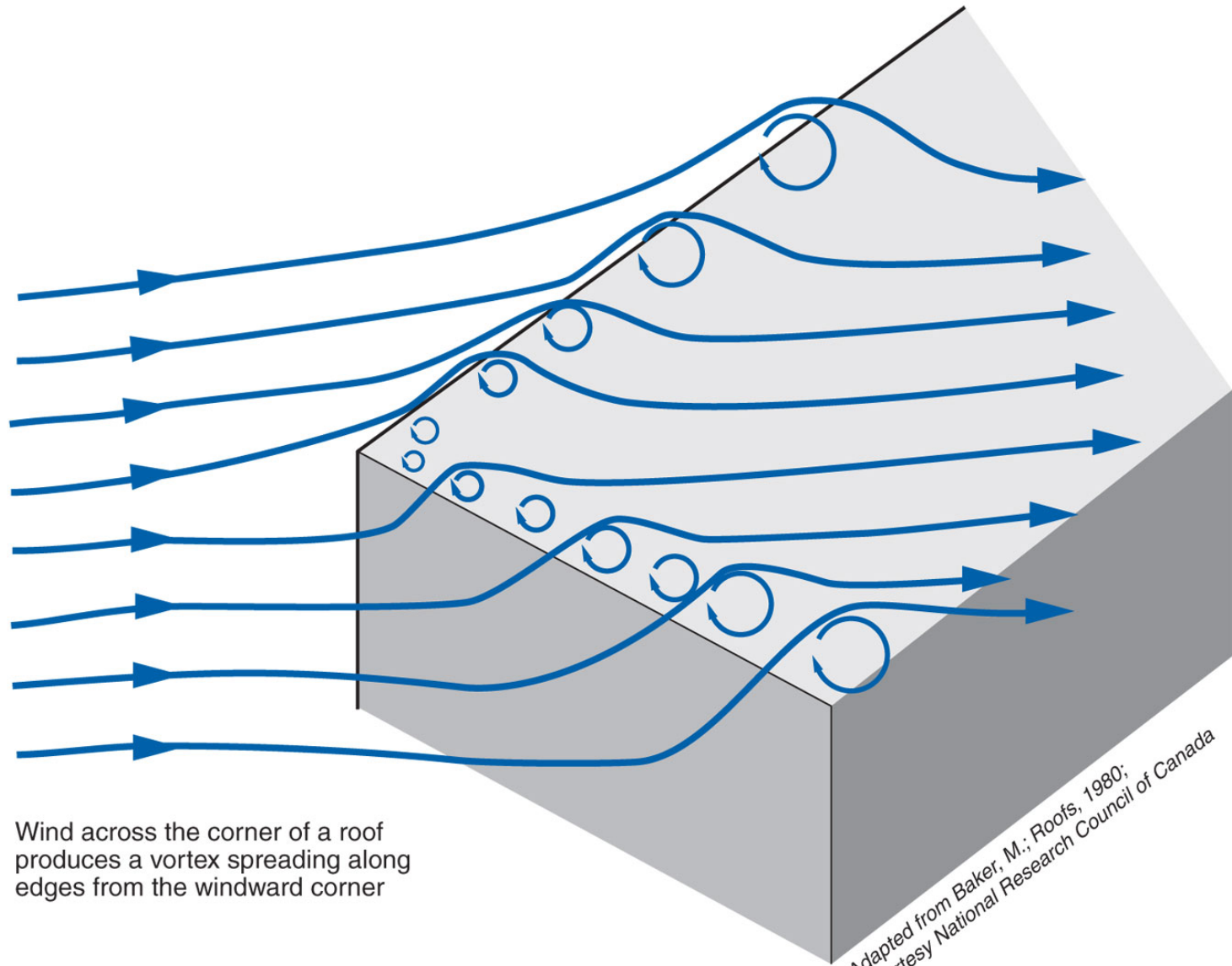


Drift on lower roof



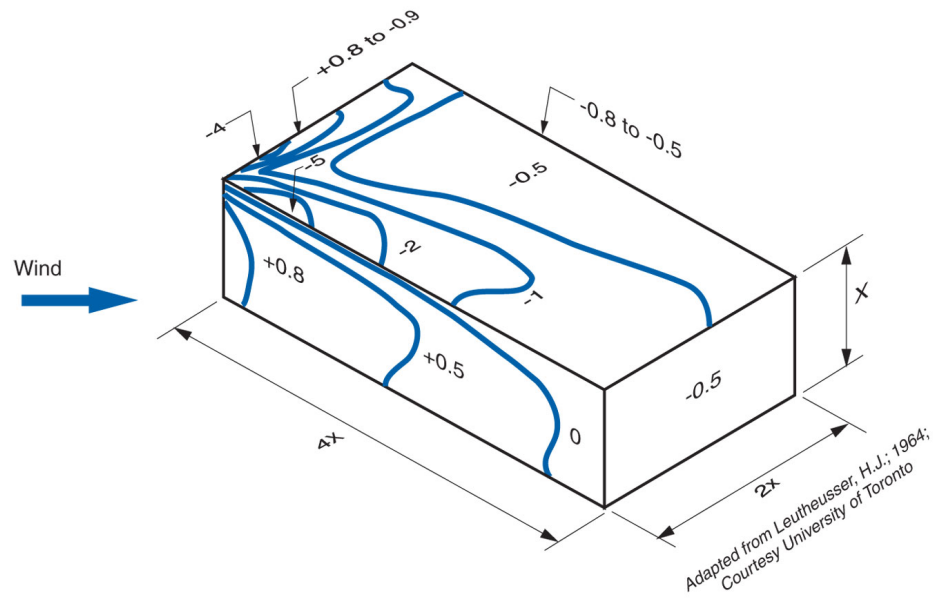
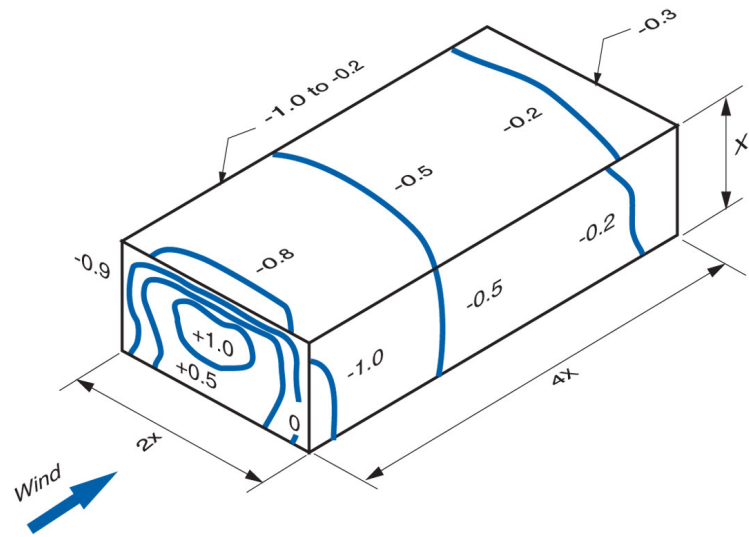
Slide off

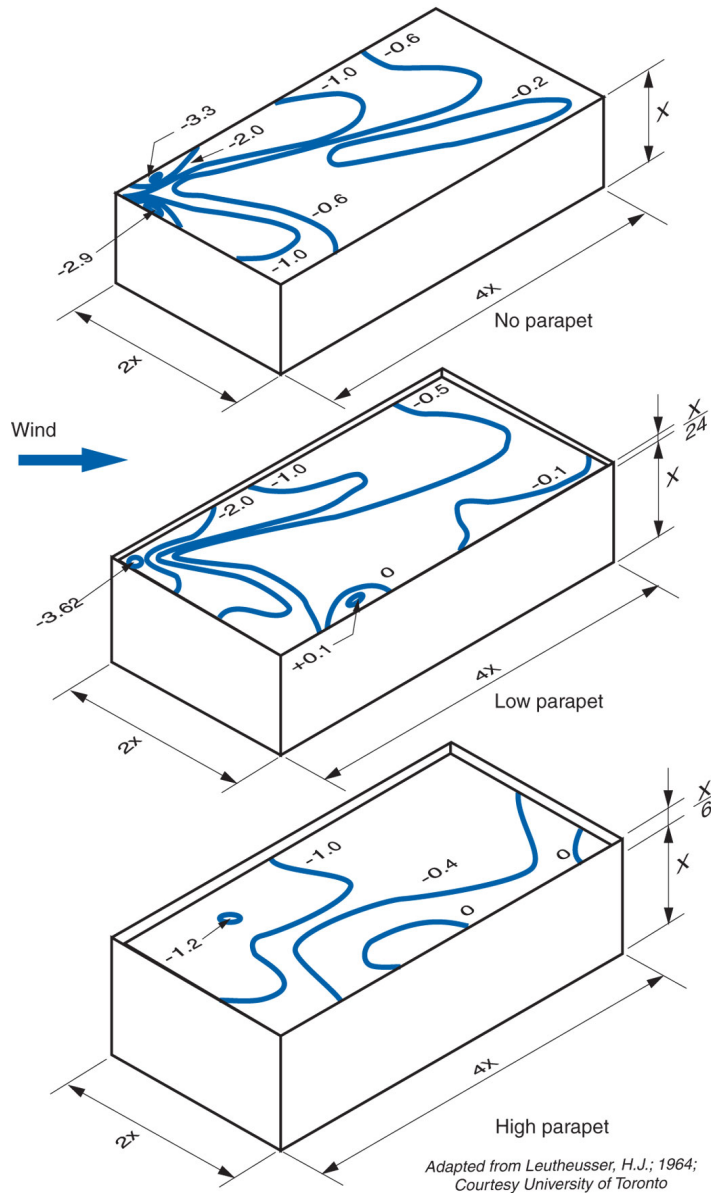
From Baker, M.; Roofs, 1980

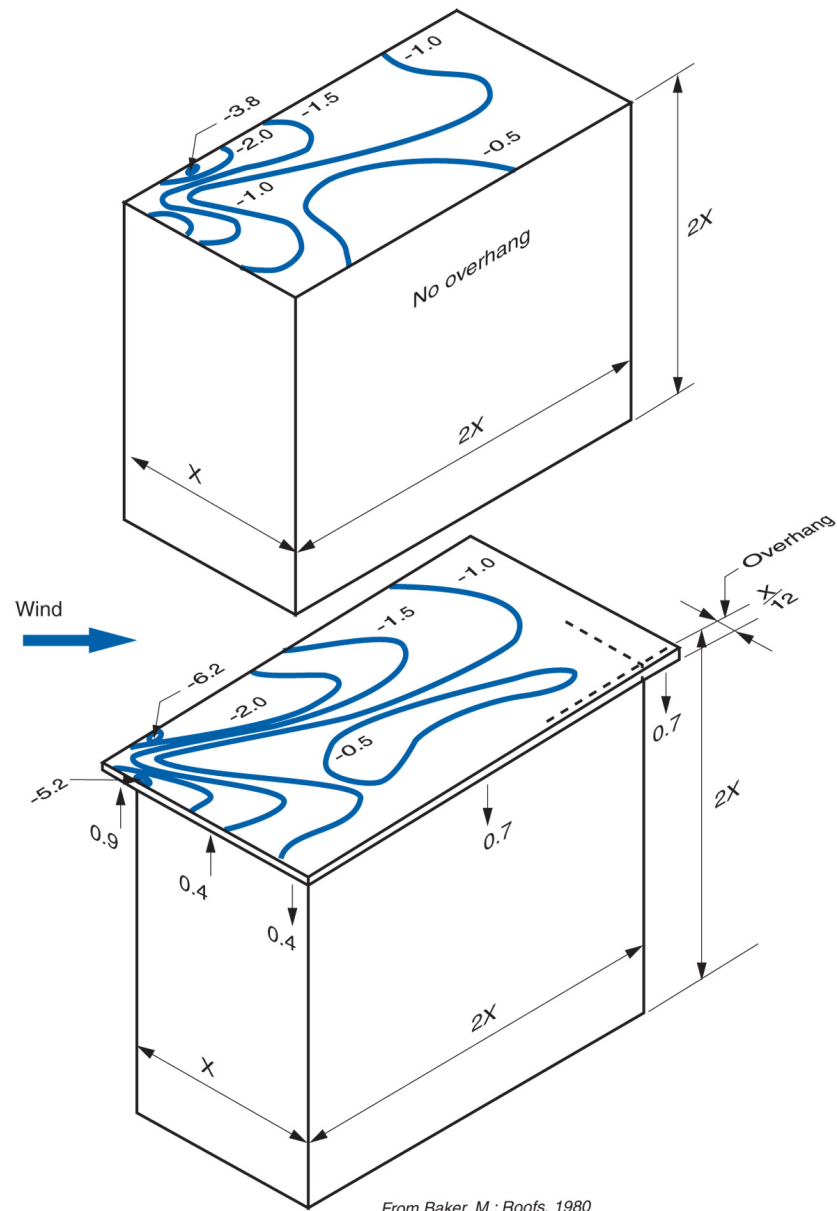


Wind across the corner of a roof produces a vortex spreading along edges from the windward corner

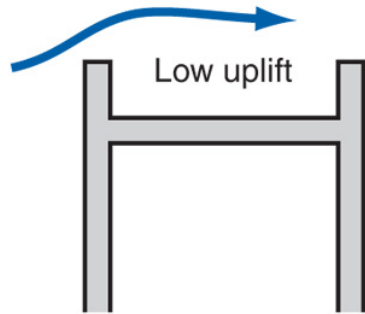
Adapted from Baker, M.; Roofs, 1980;
Courtesy National Research Council of Canada



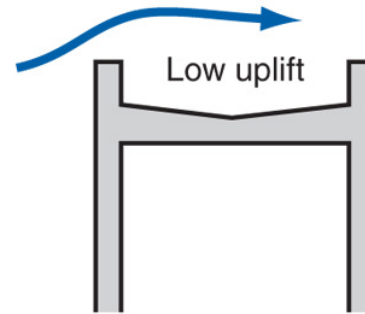




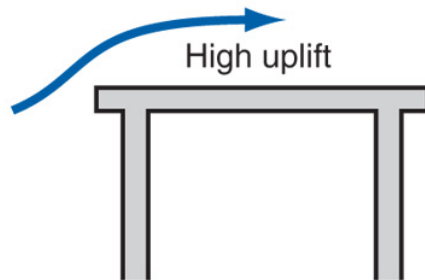
From Baker, M.; Roofs, 1980



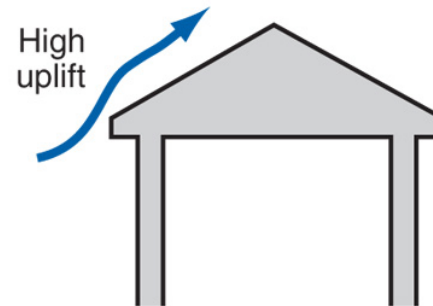
Flat roof with parapets
blow-off hazard: low
slippage hazard: low



Sloped roof with parapets
blow-off hazard: low
slippage hazard: medium

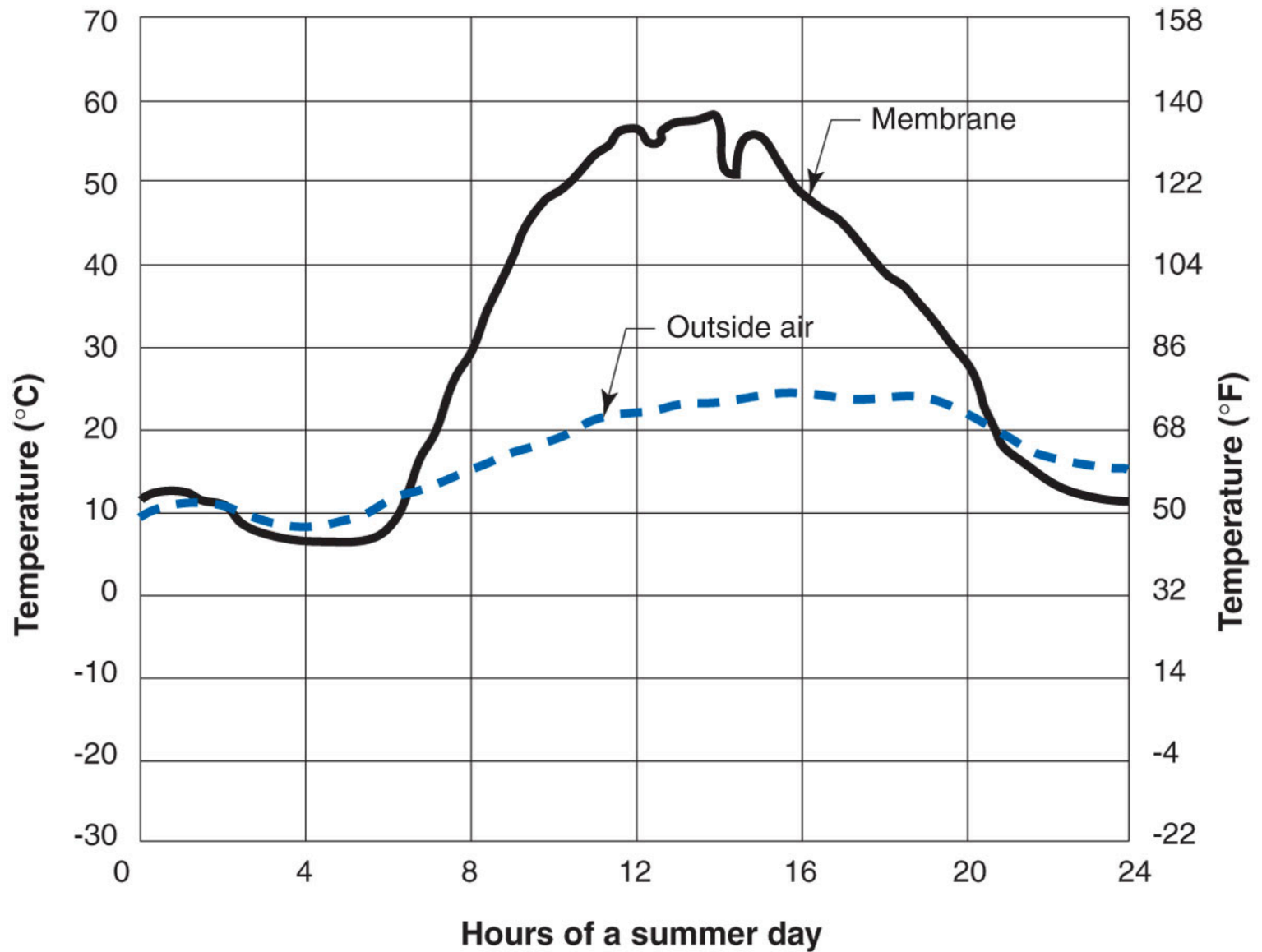


Flat roof or overhang
blow off hazard: high
slippage hazard: low



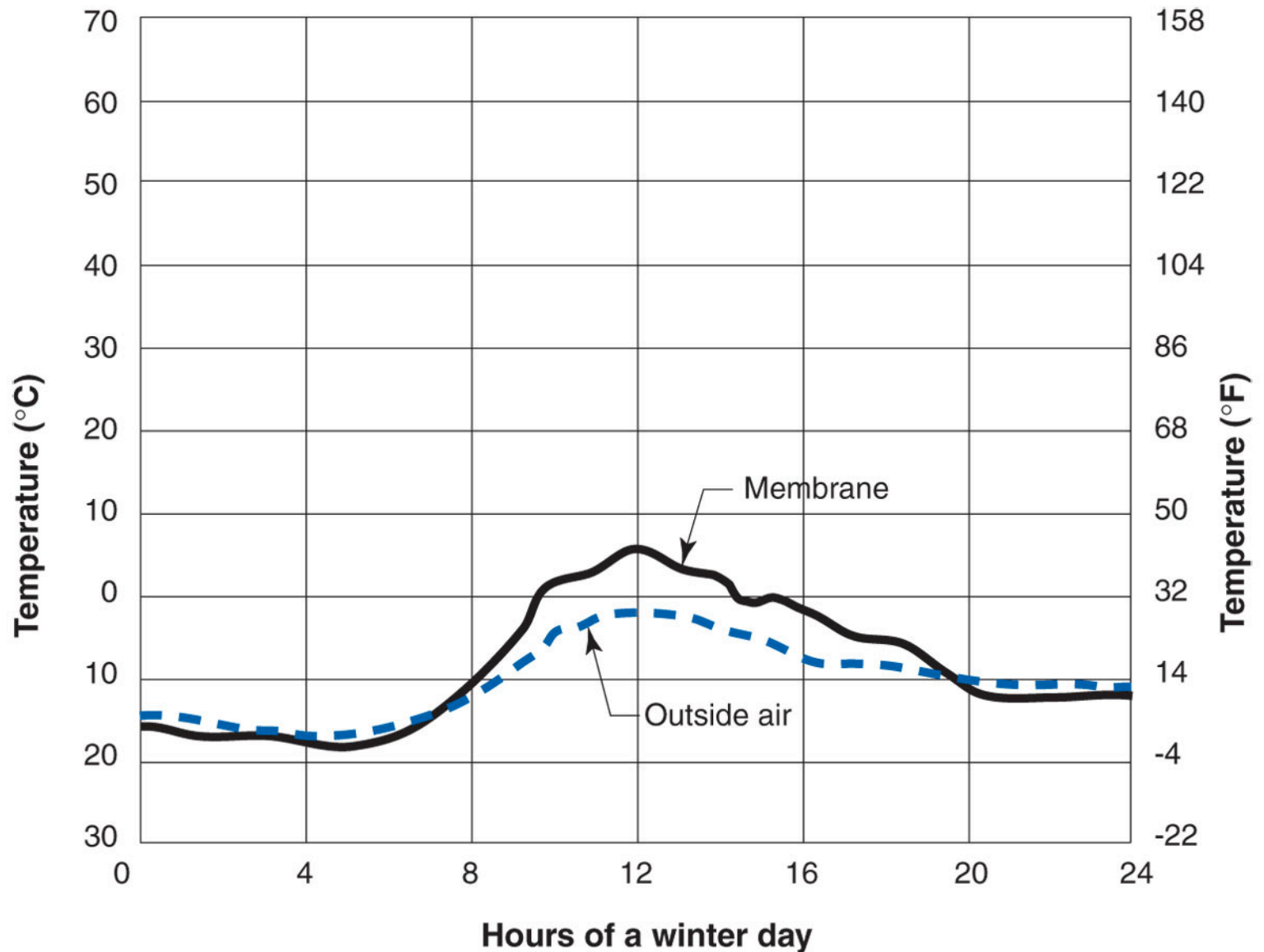
Outward sloping roof
blow-off hazard: high
slippage hazard: high

From Baker, M.; Roofs, 1980



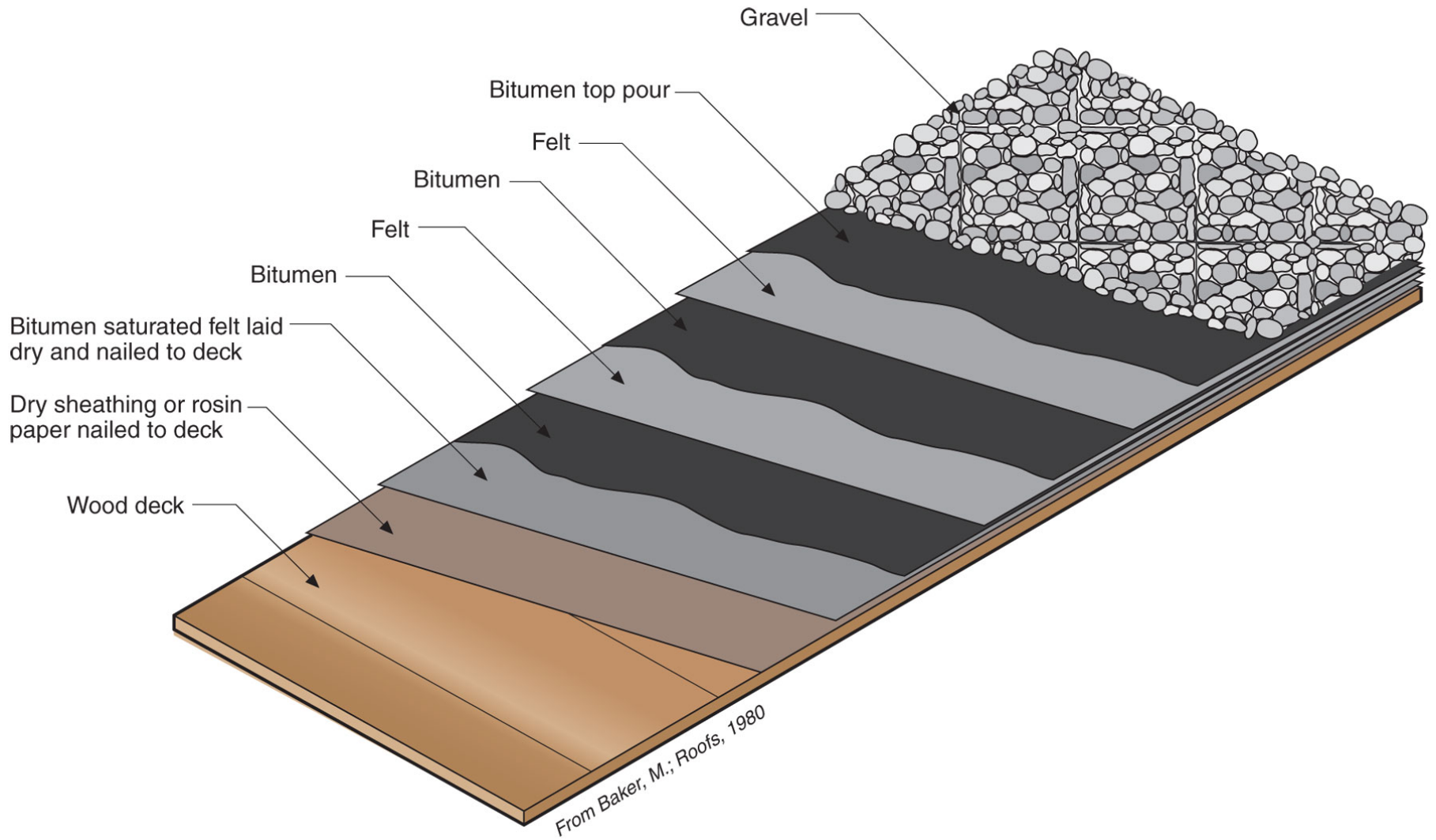
Hours of a summer day

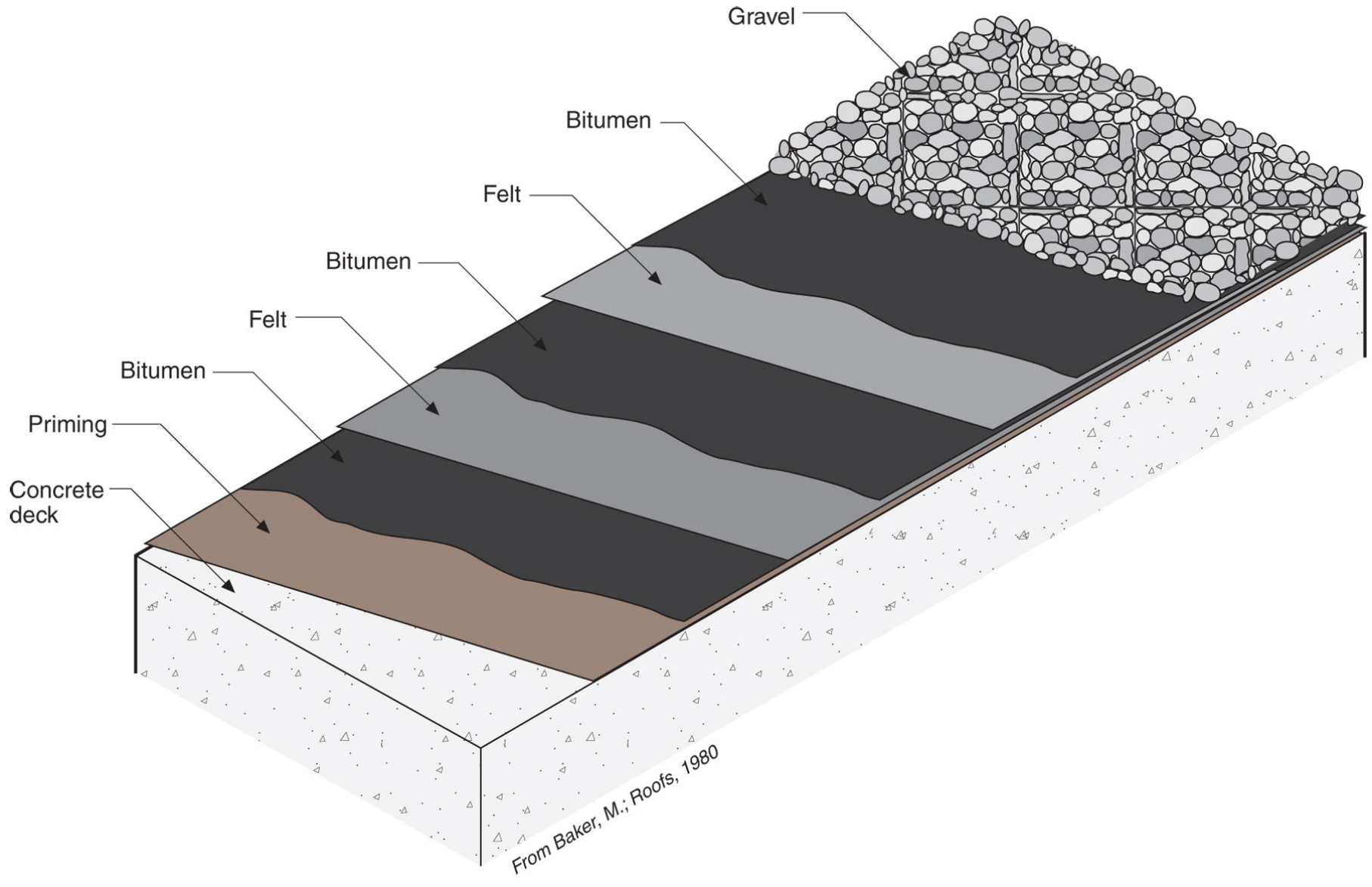
From Baker, M.; Roofs, 1980

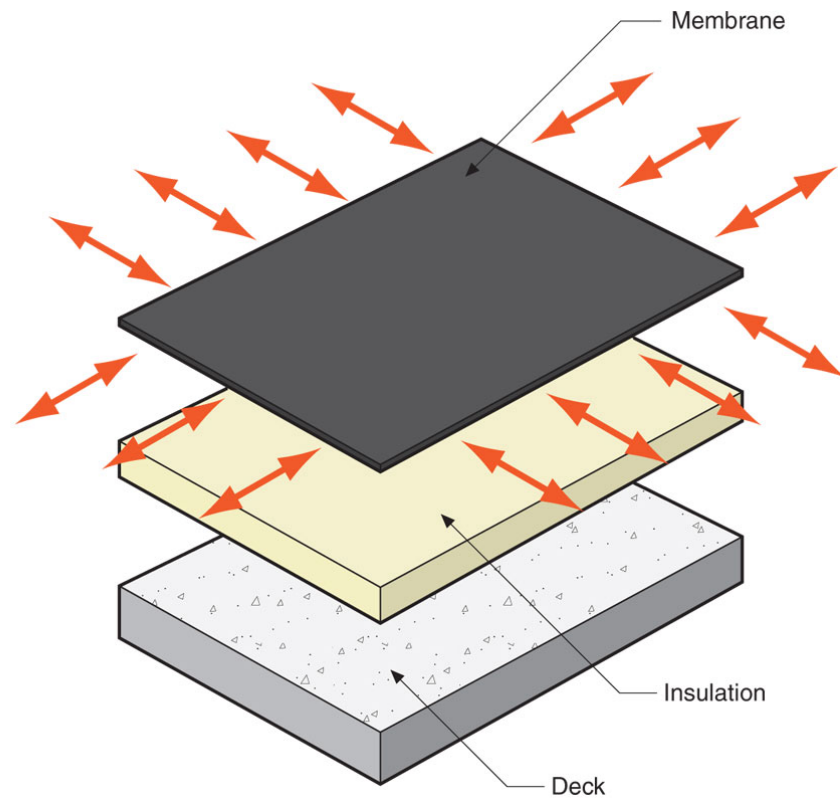
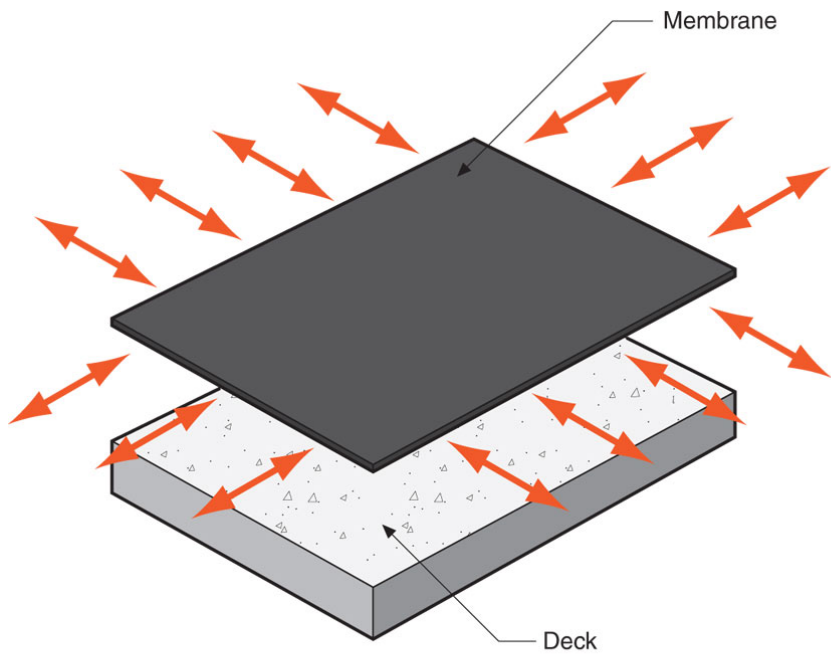


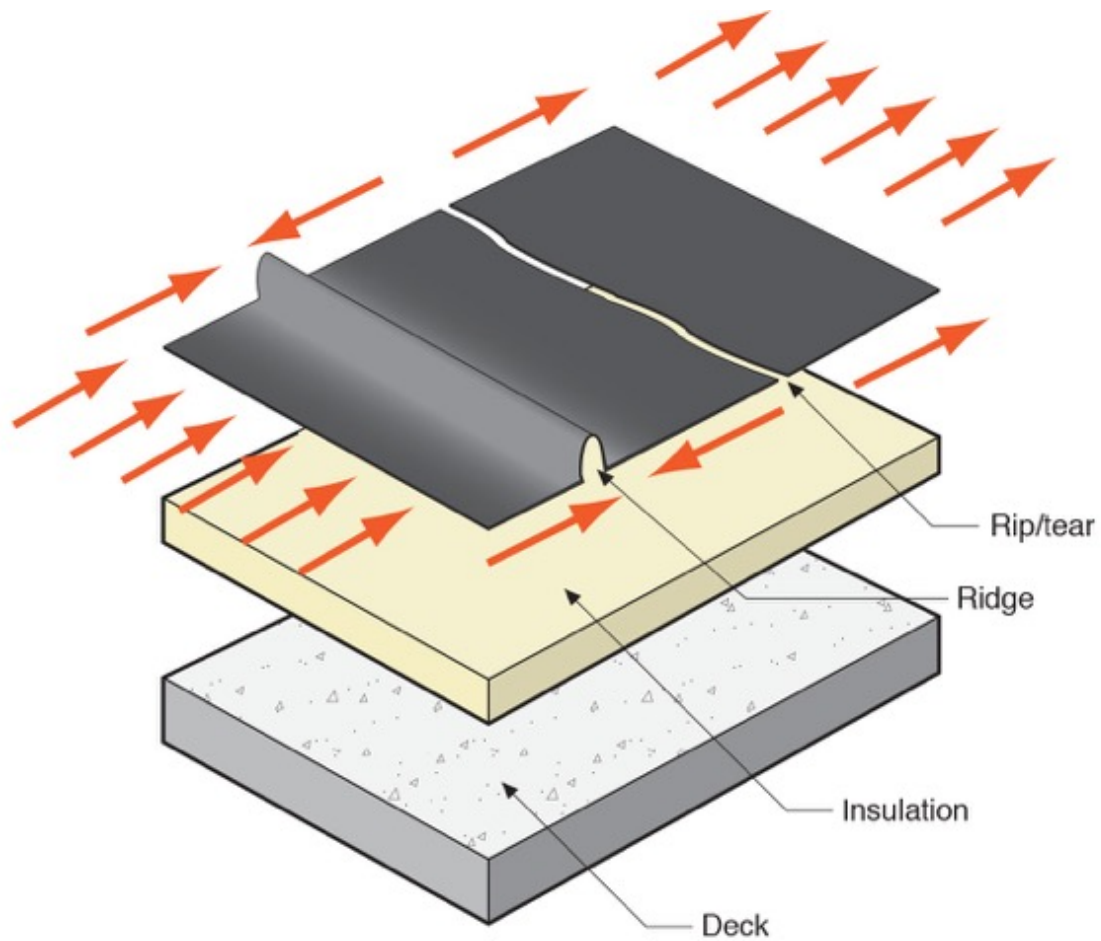
Hours of a winter day

From Baker, M.; Roofs, 1980

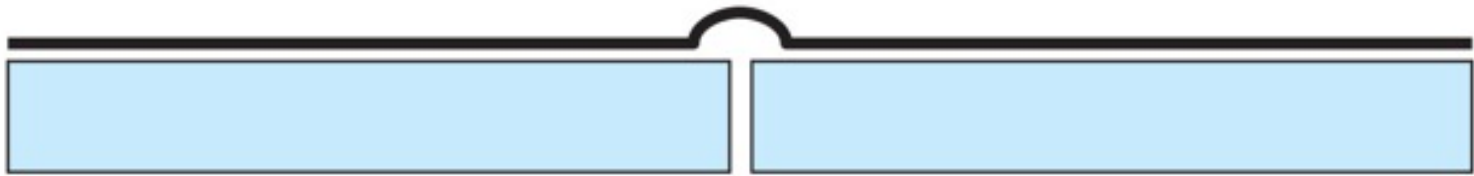
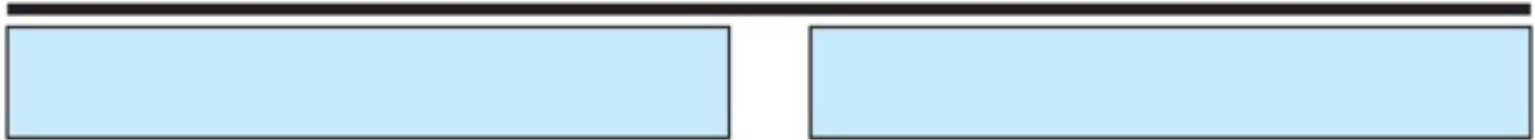


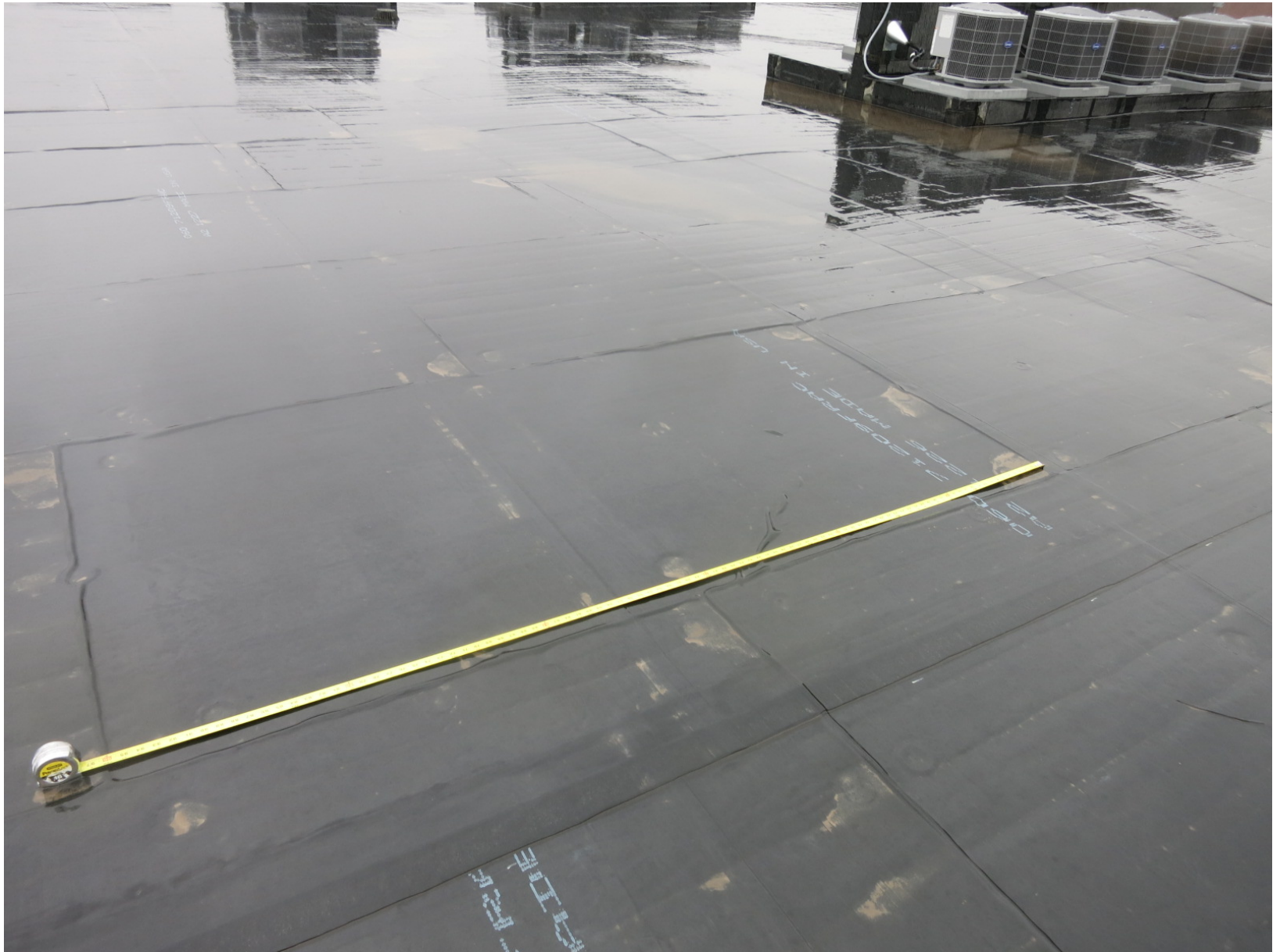


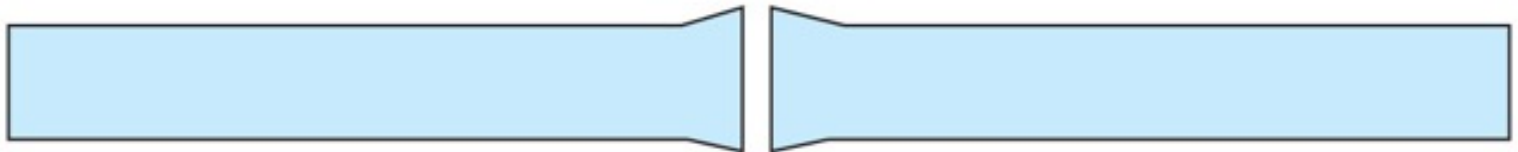
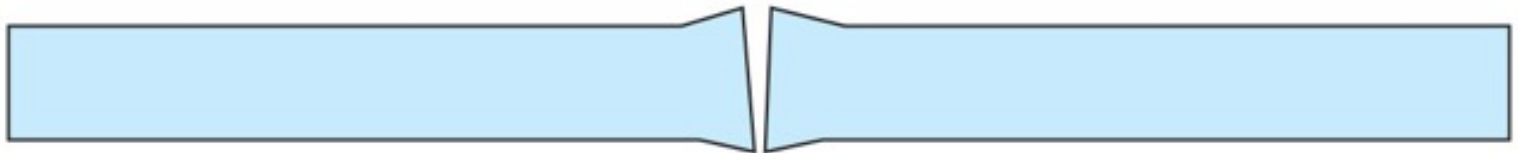
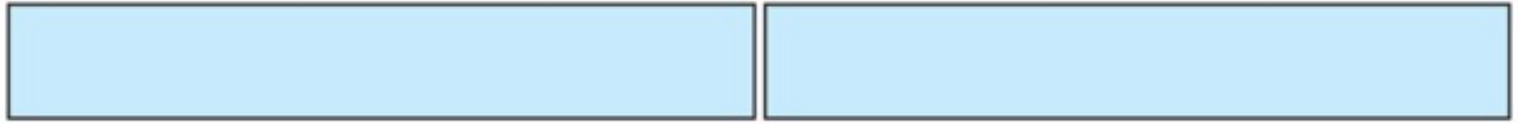


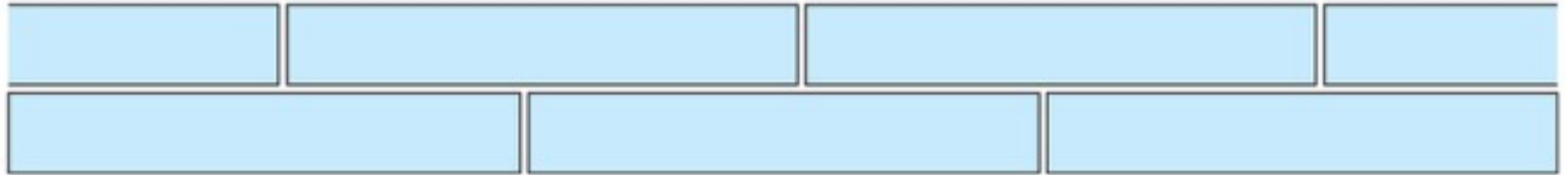






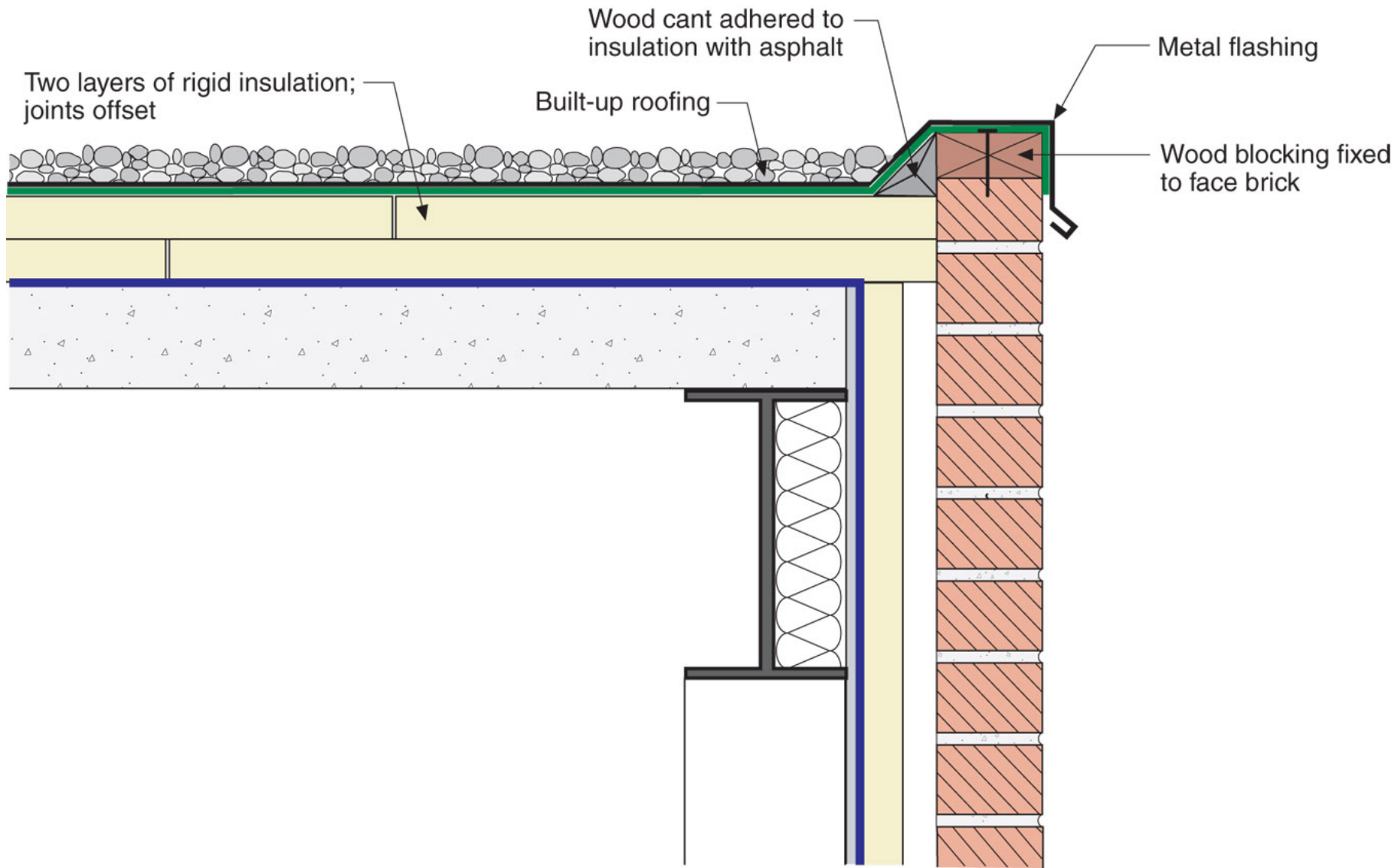






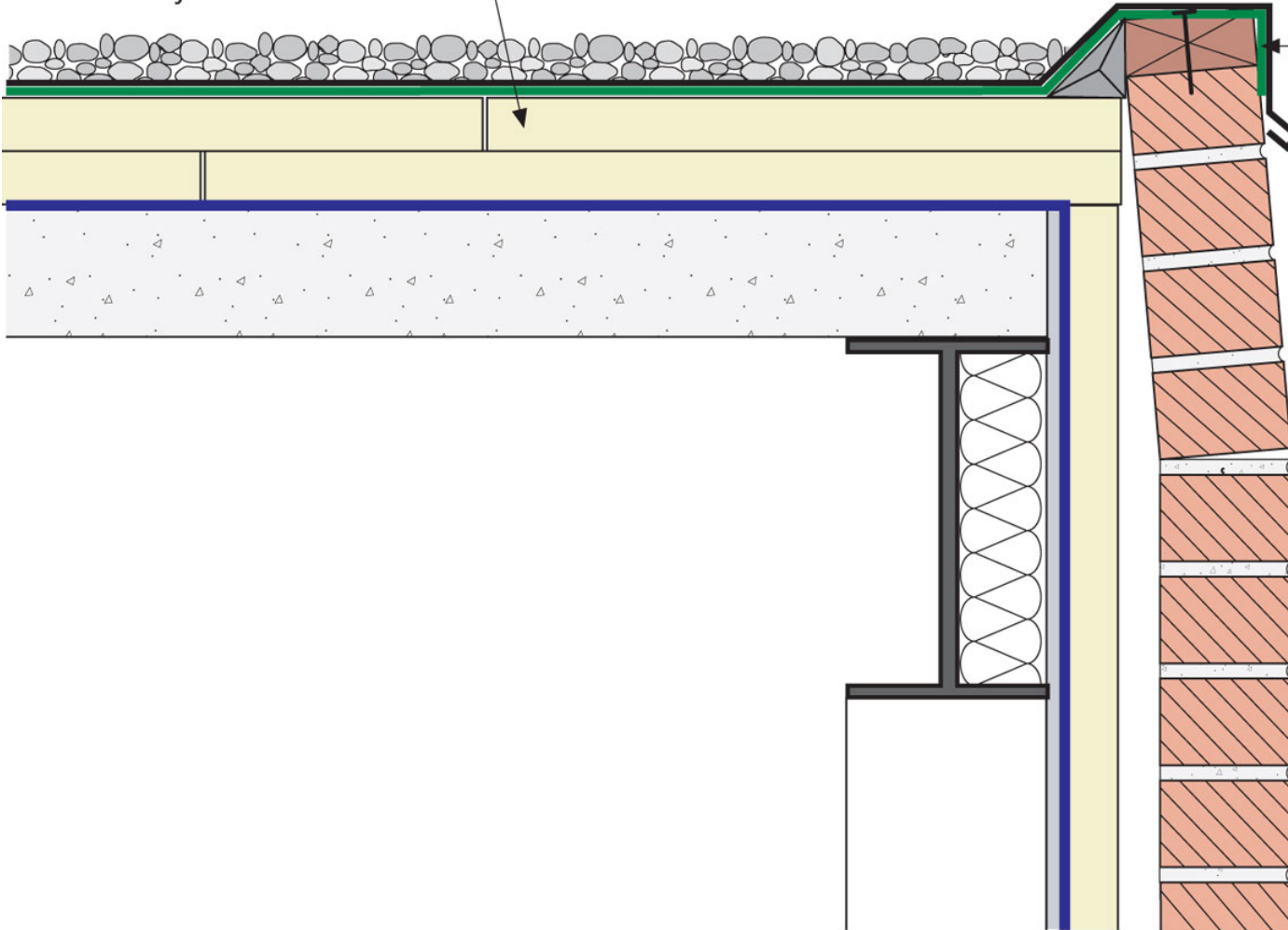






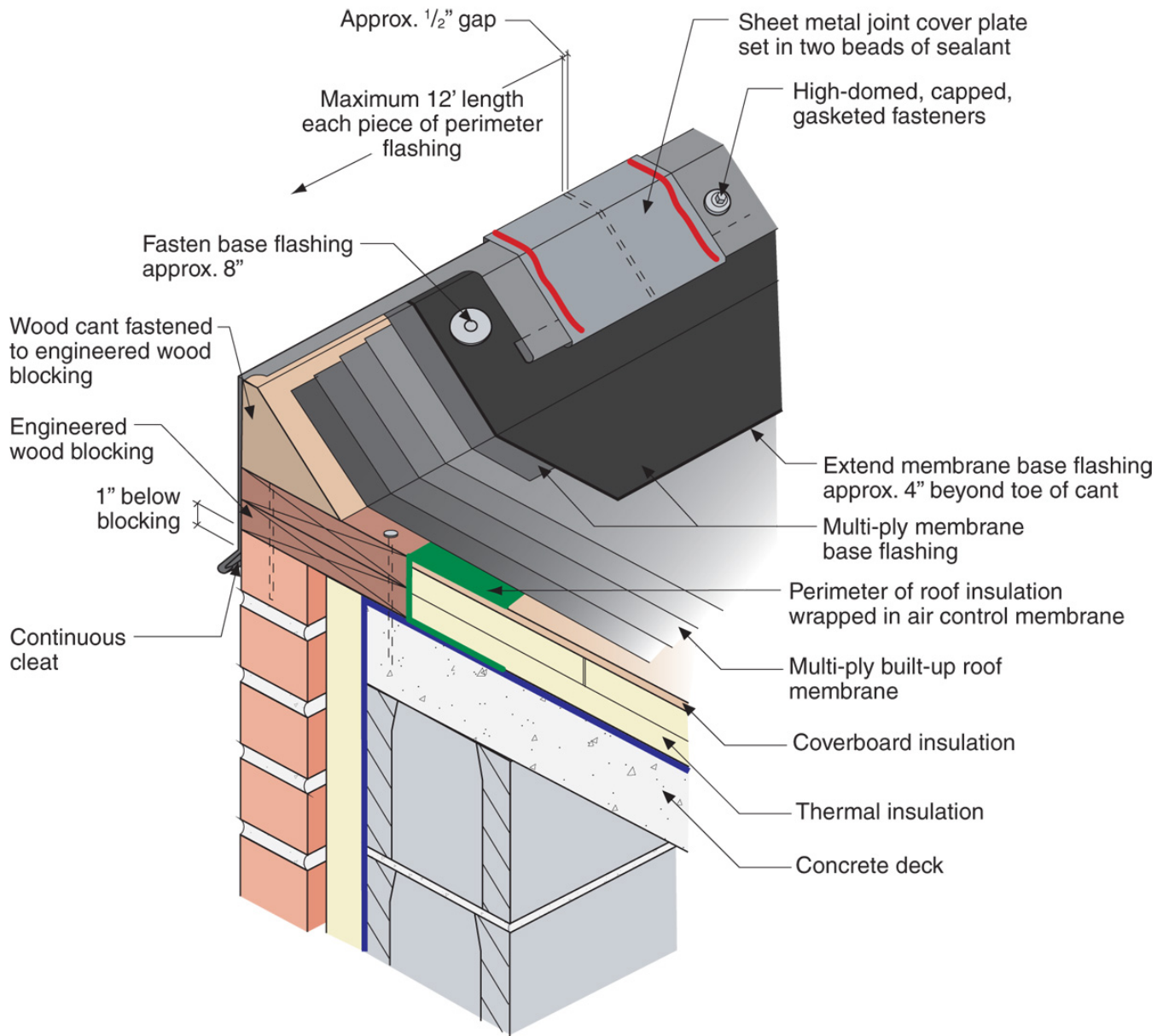
Adapted from Baker, M.; *Roofs*, 1980

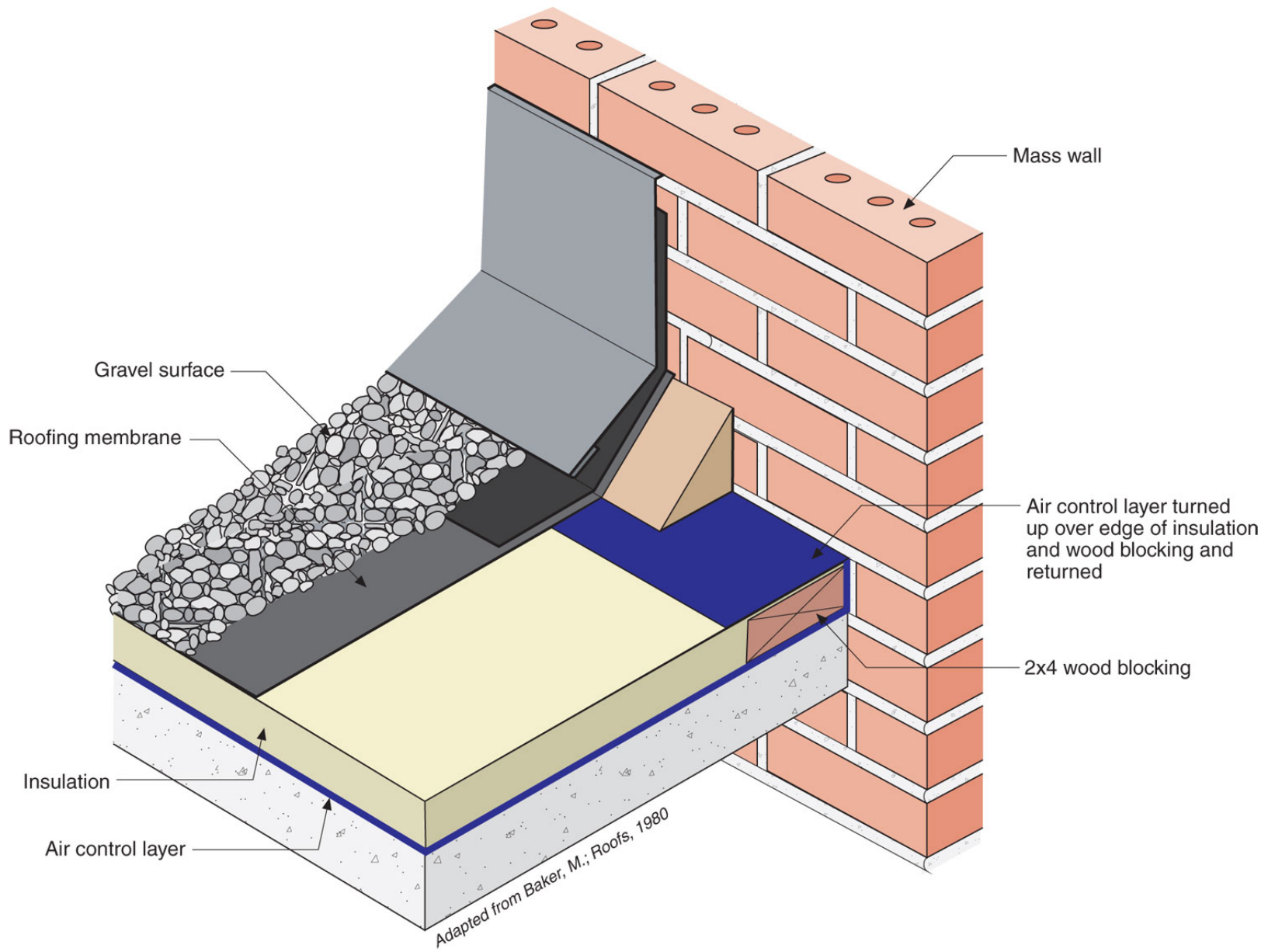
Insulation moved because of poor adhesion to deck and between layers

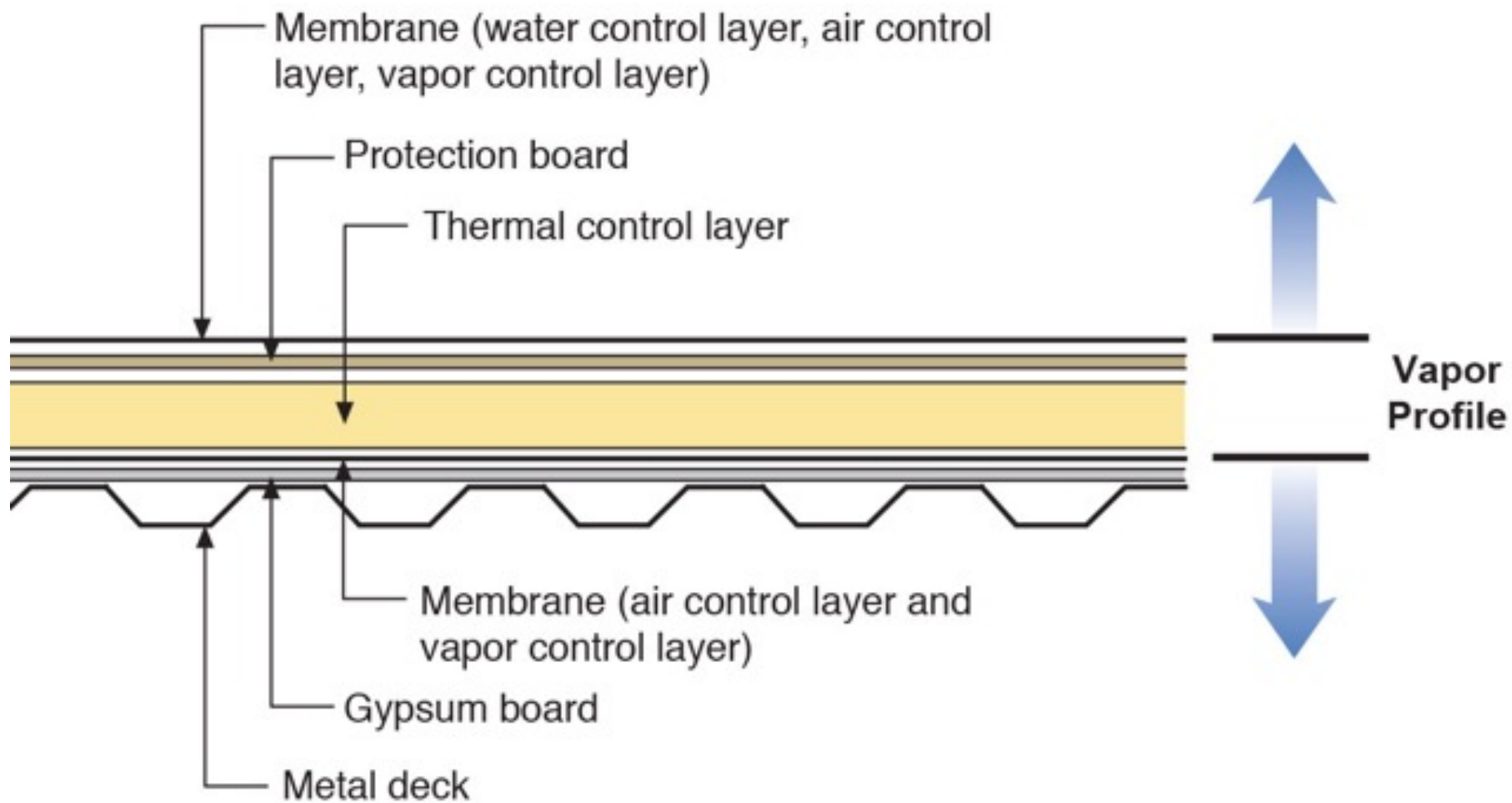


Top four courses of brick and wood blocking pulled inward by contracting membrane

*Adapted from Baker, M.; Roofs, 1980;
Courtesy National Research Council of Canada*



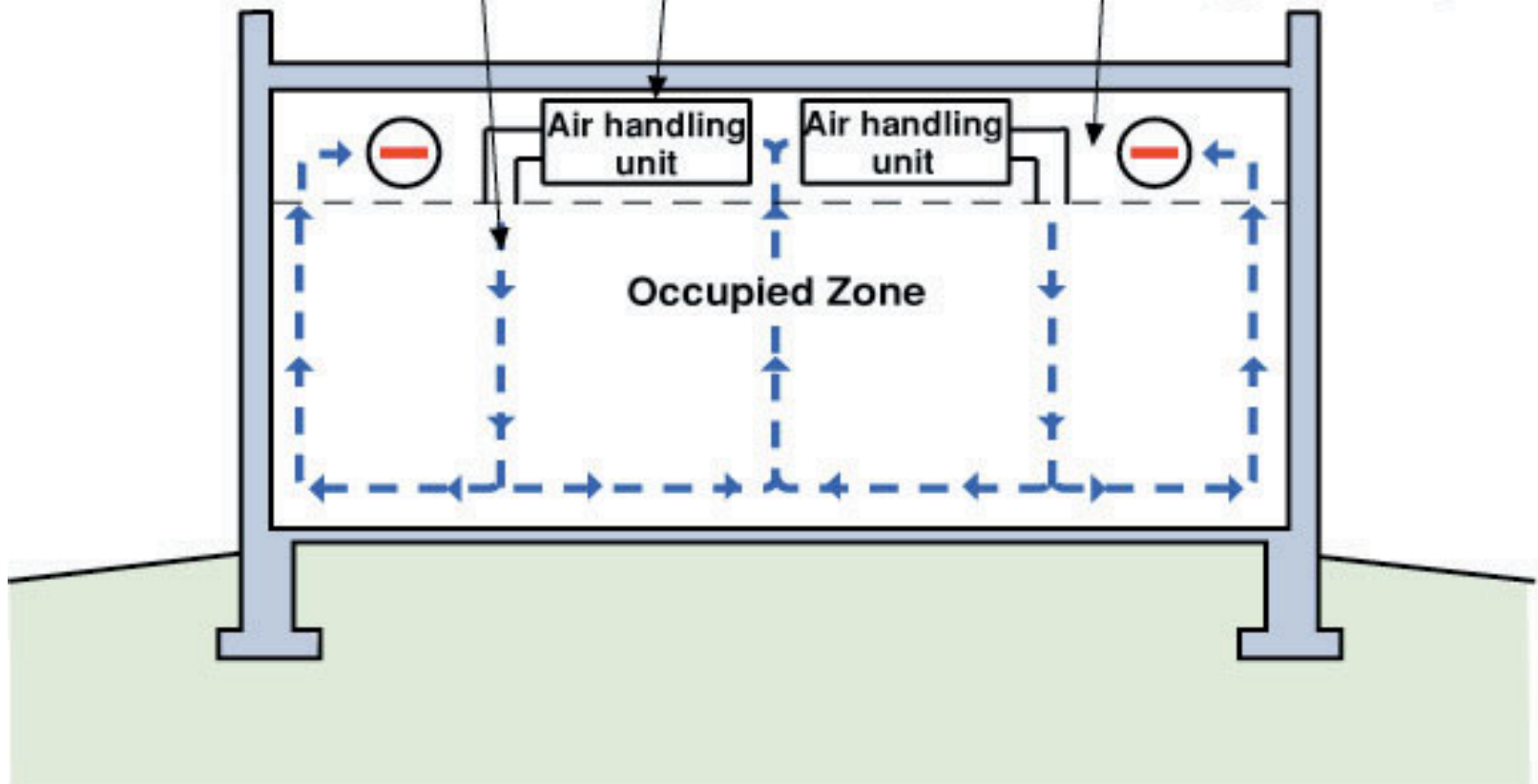


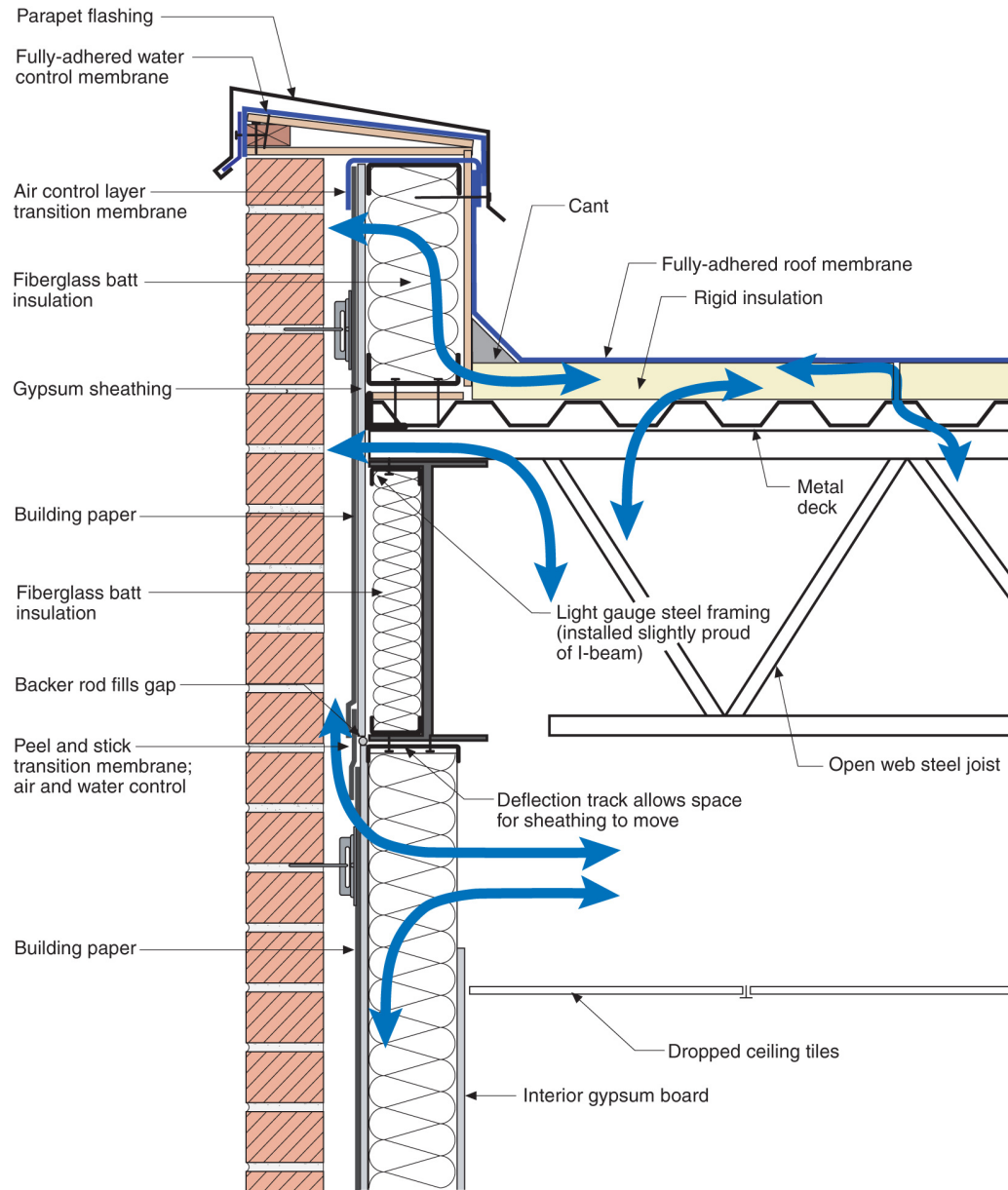


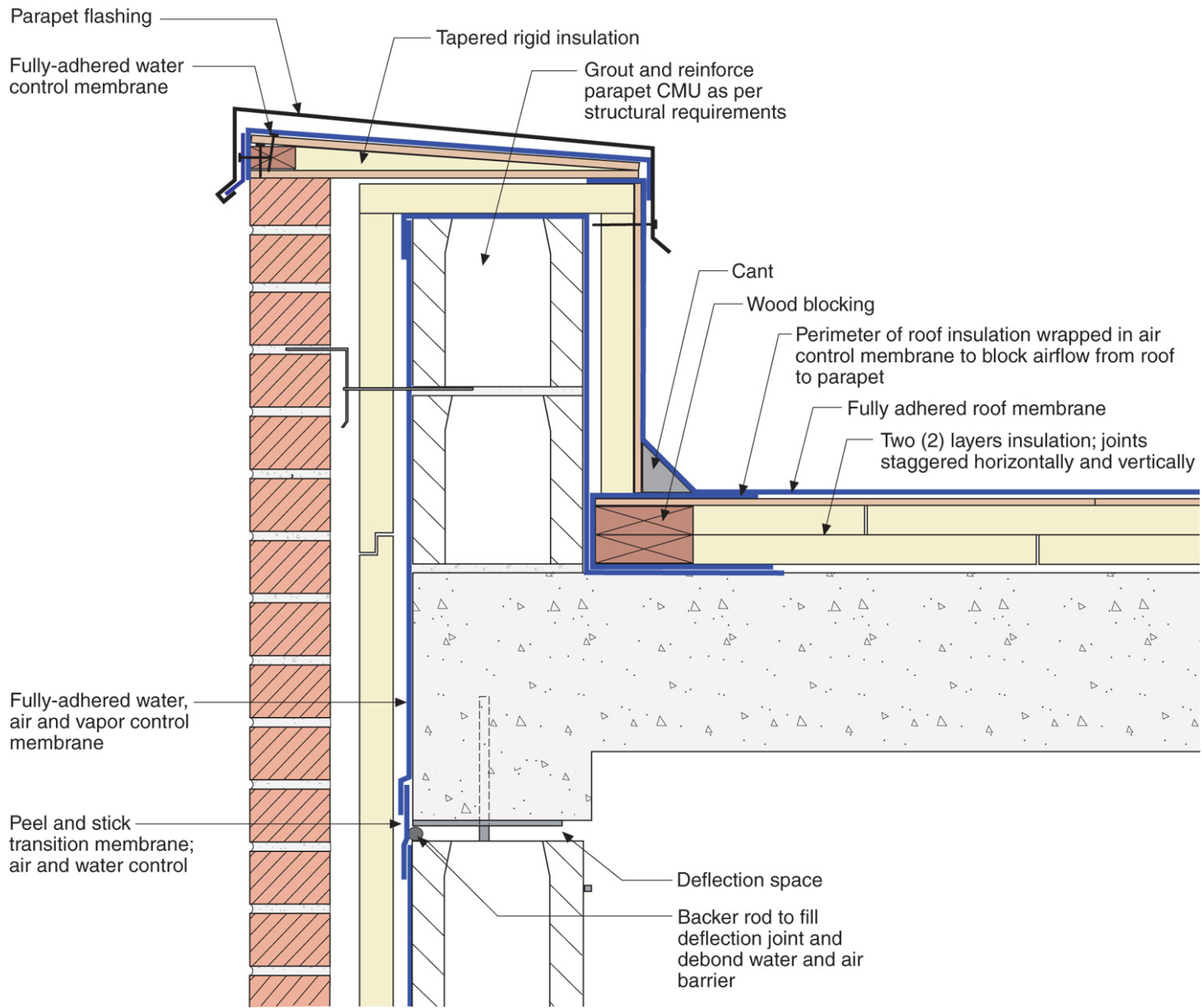
Supply air into occupied zone returns to AHU by passing through deliberately porous dropped ceiling or through return grilles installed in dropped ceiling

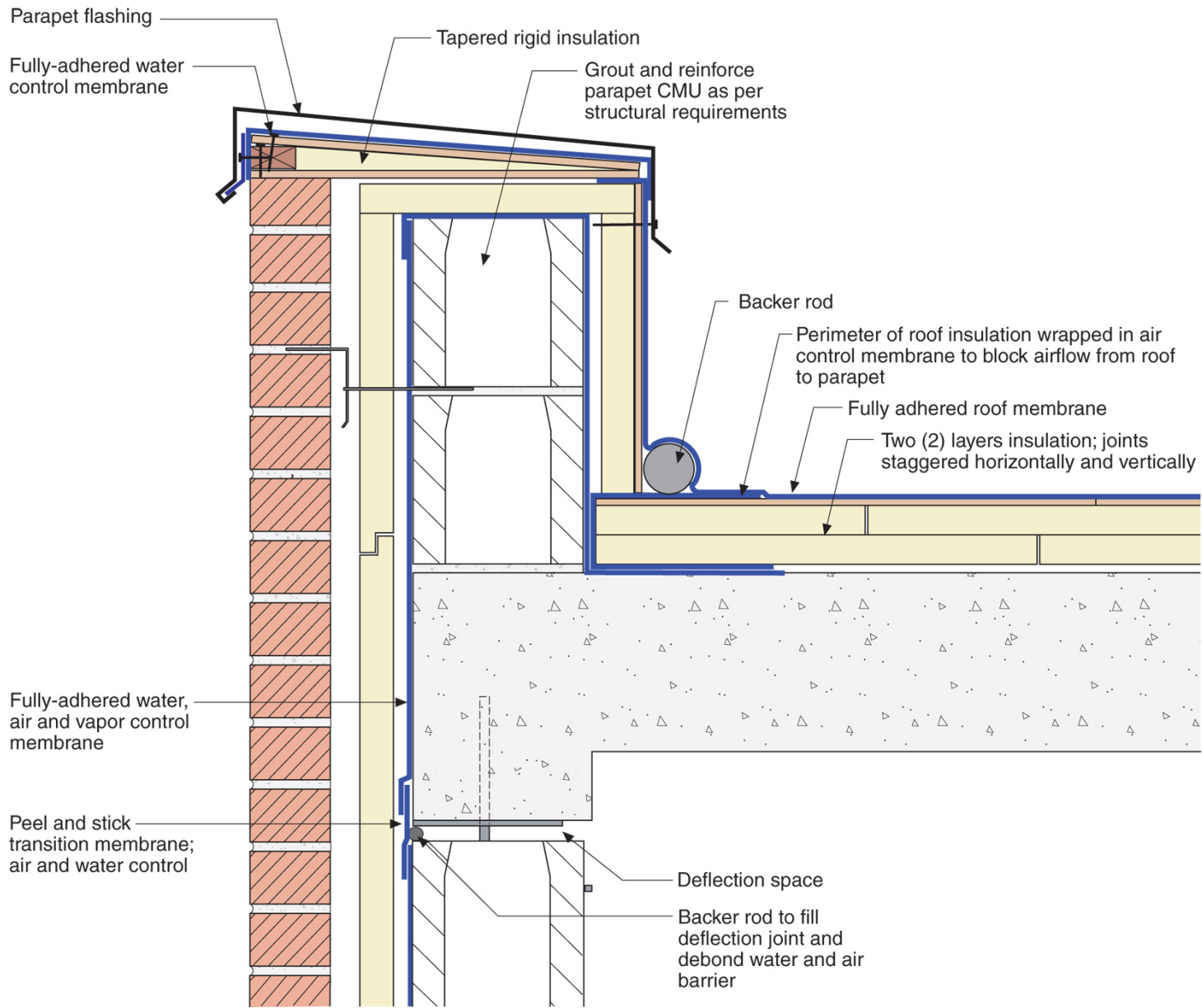
Air handling unit extracts air from dropped ceiling, conditions it and injects it into the occupied zones via supply ductwork

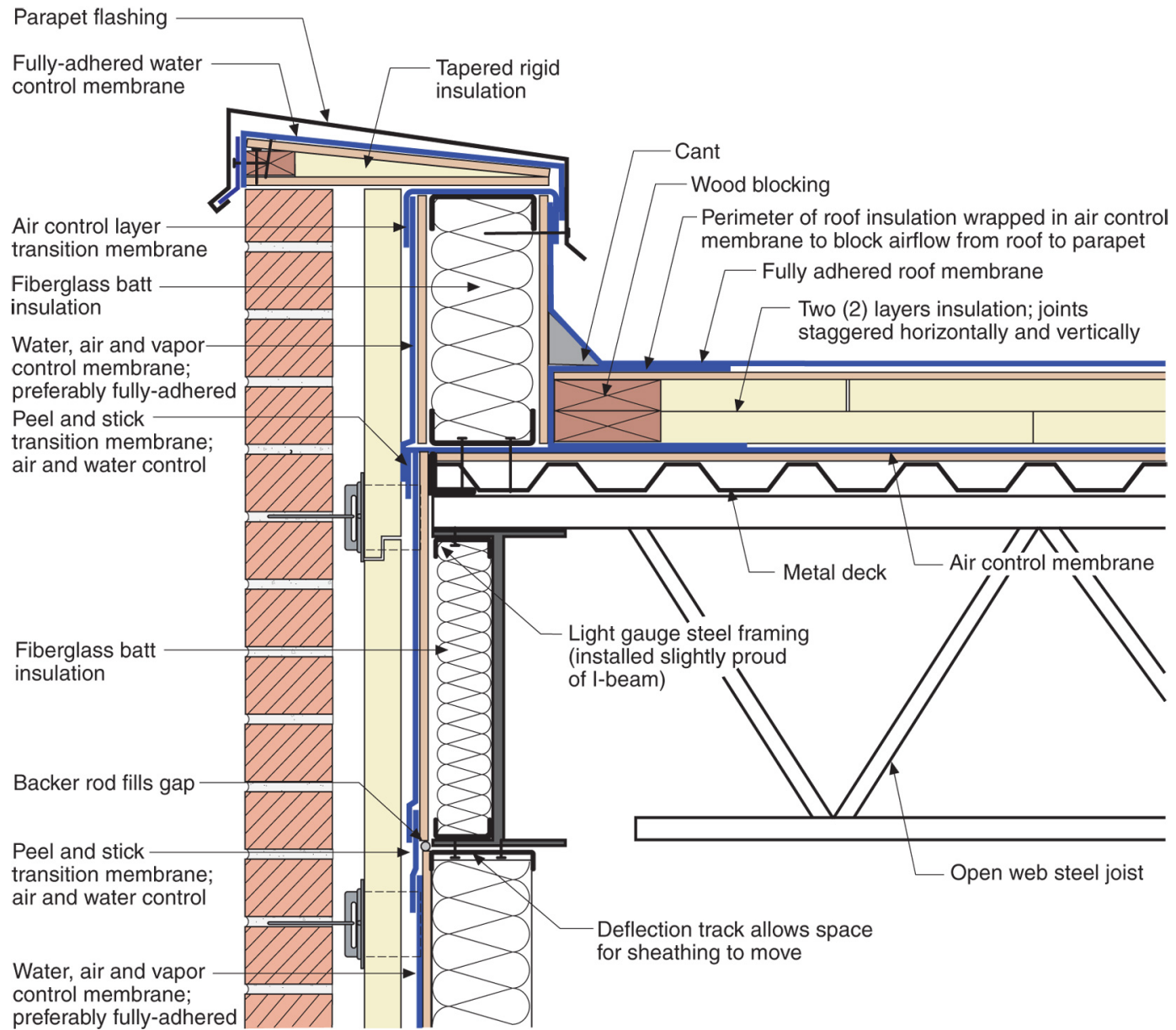
Dropped ceiling depressurized by air handling units extracting air from dropped ceiling

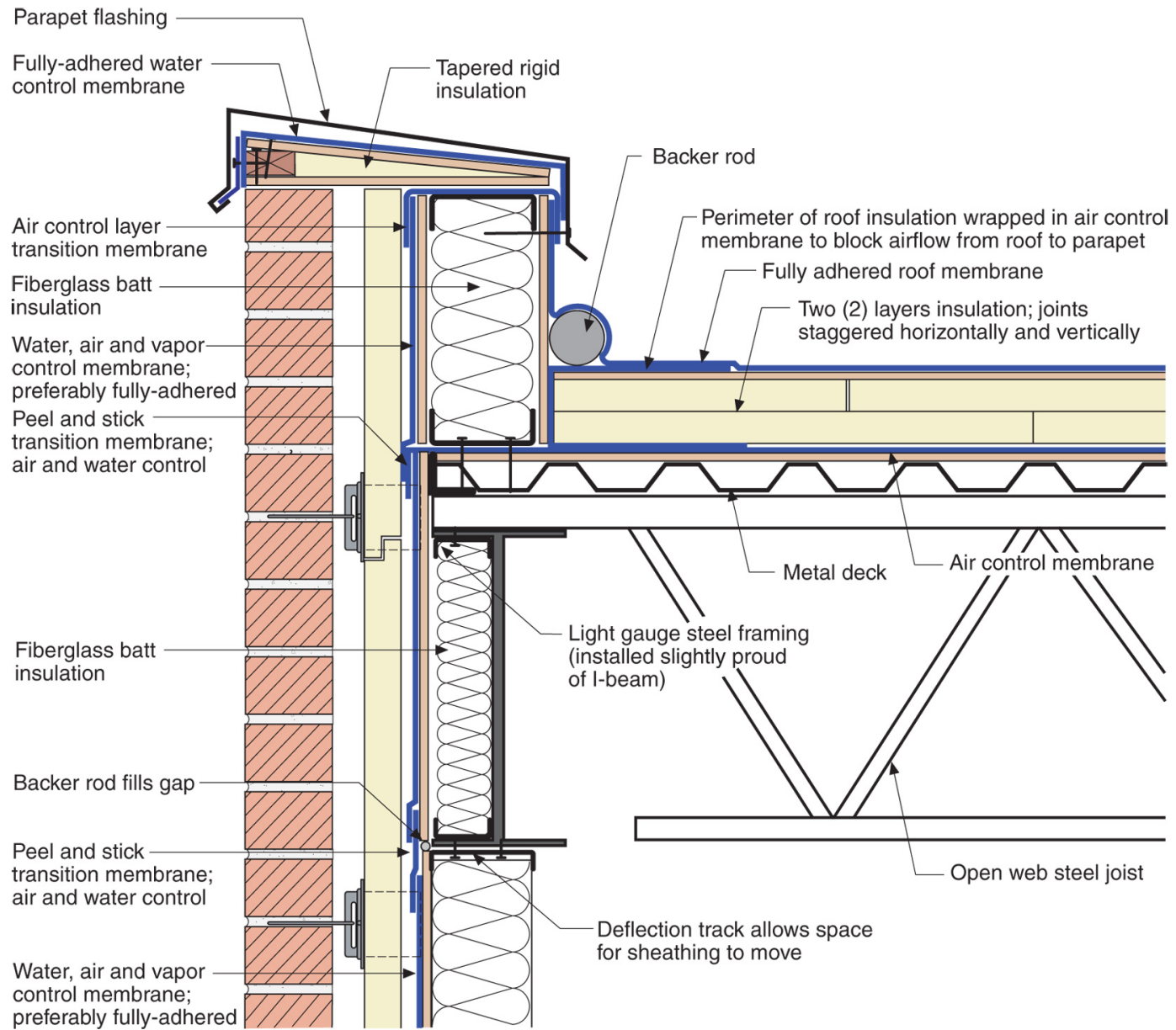


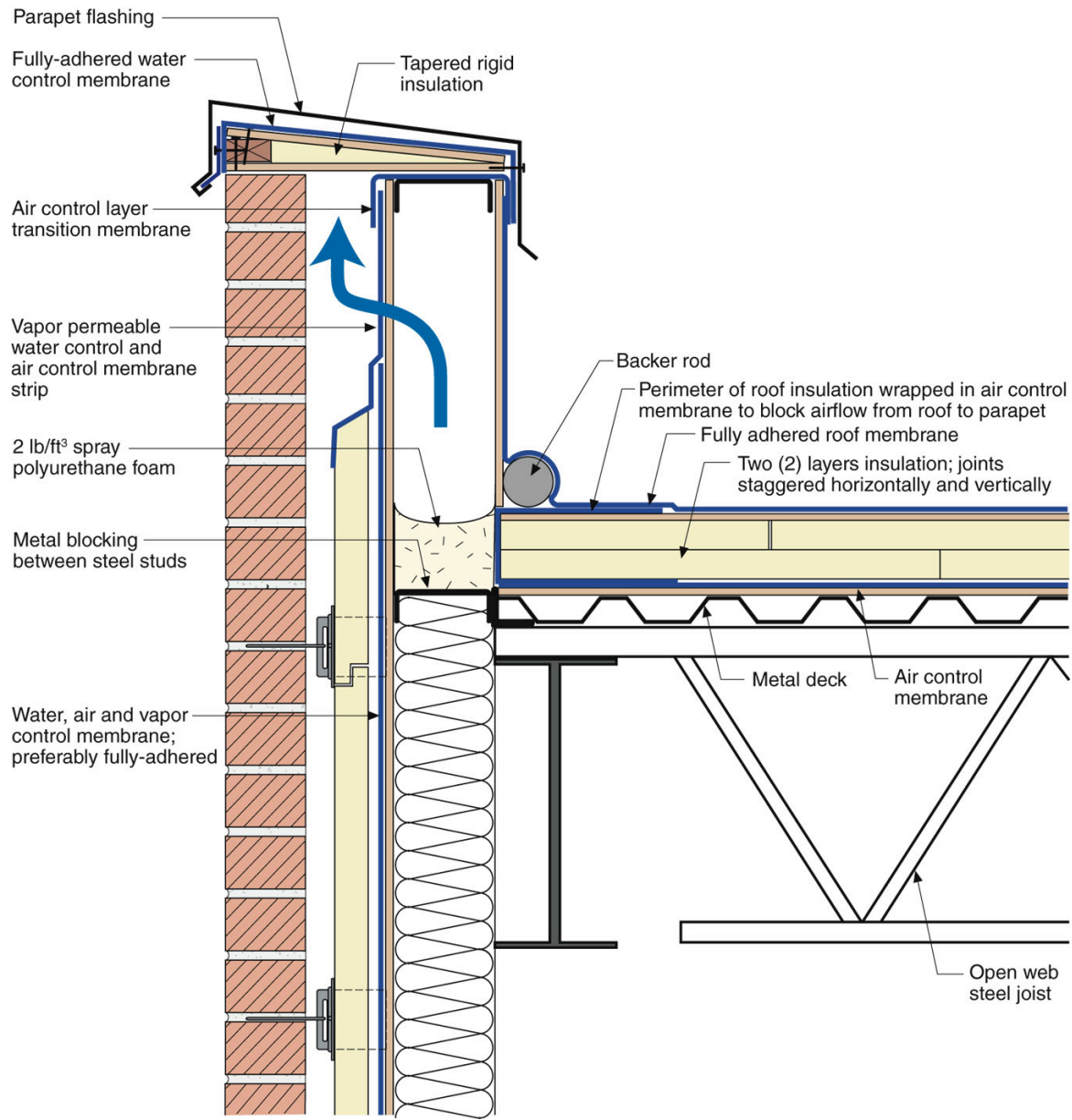


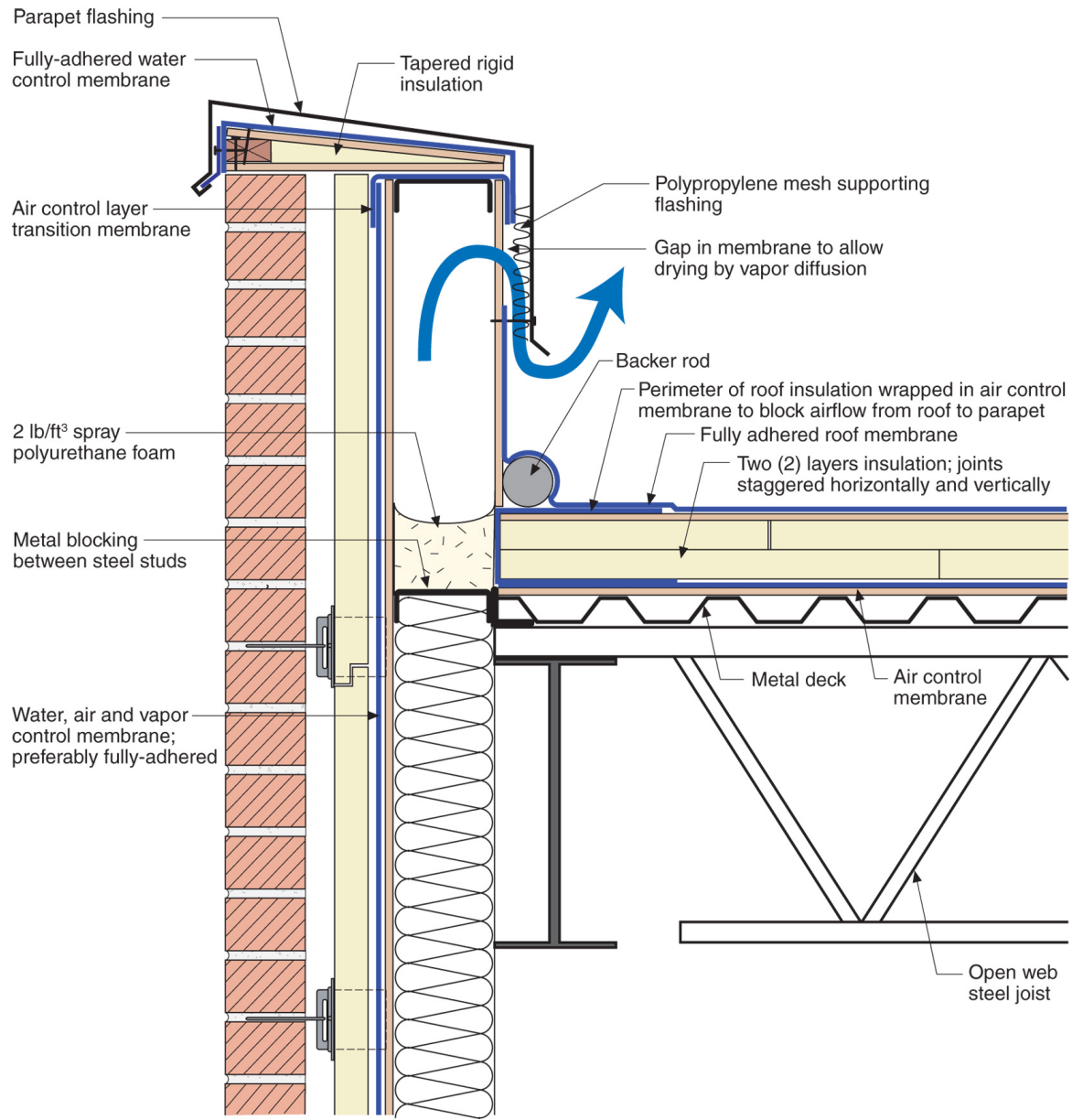


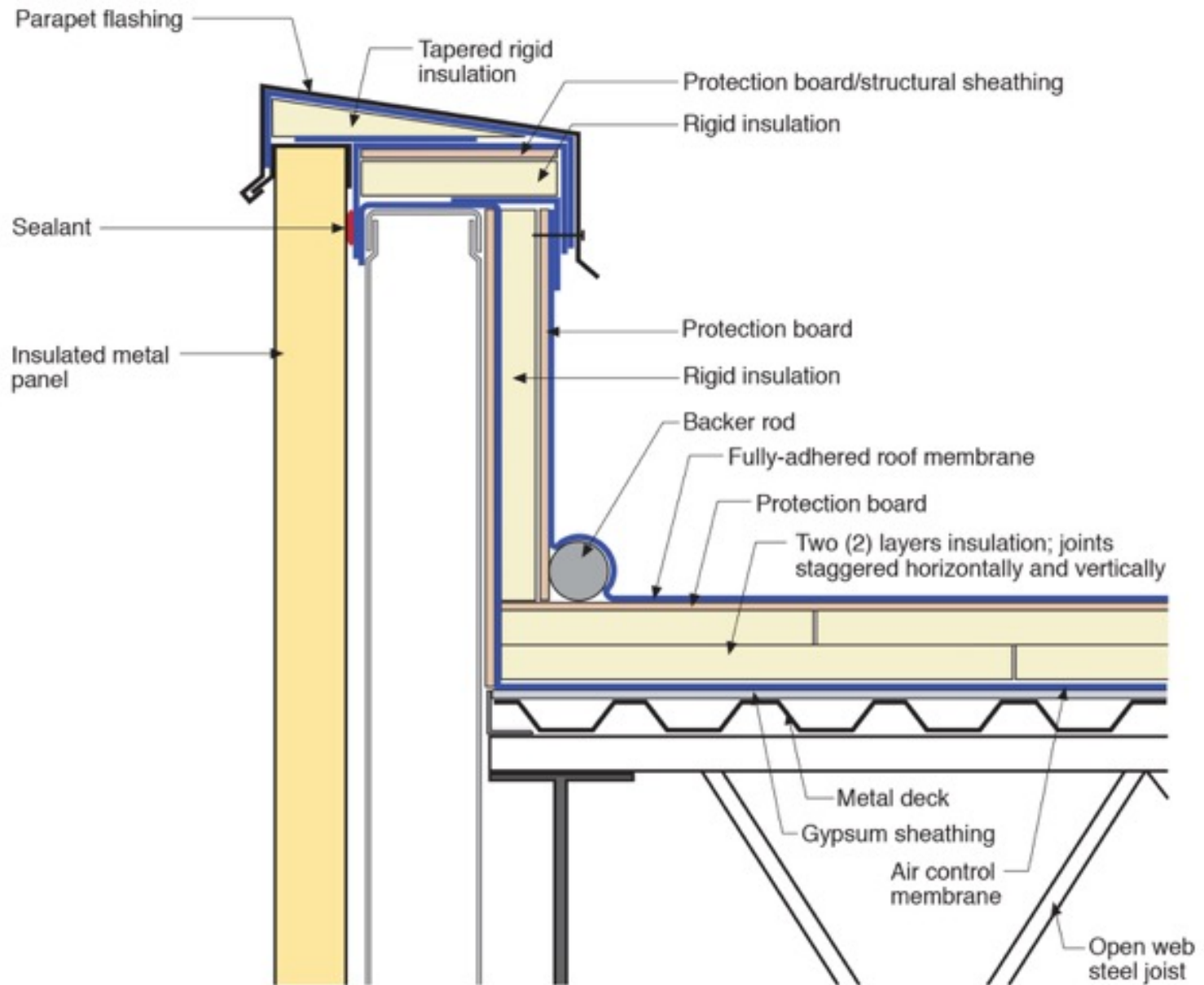


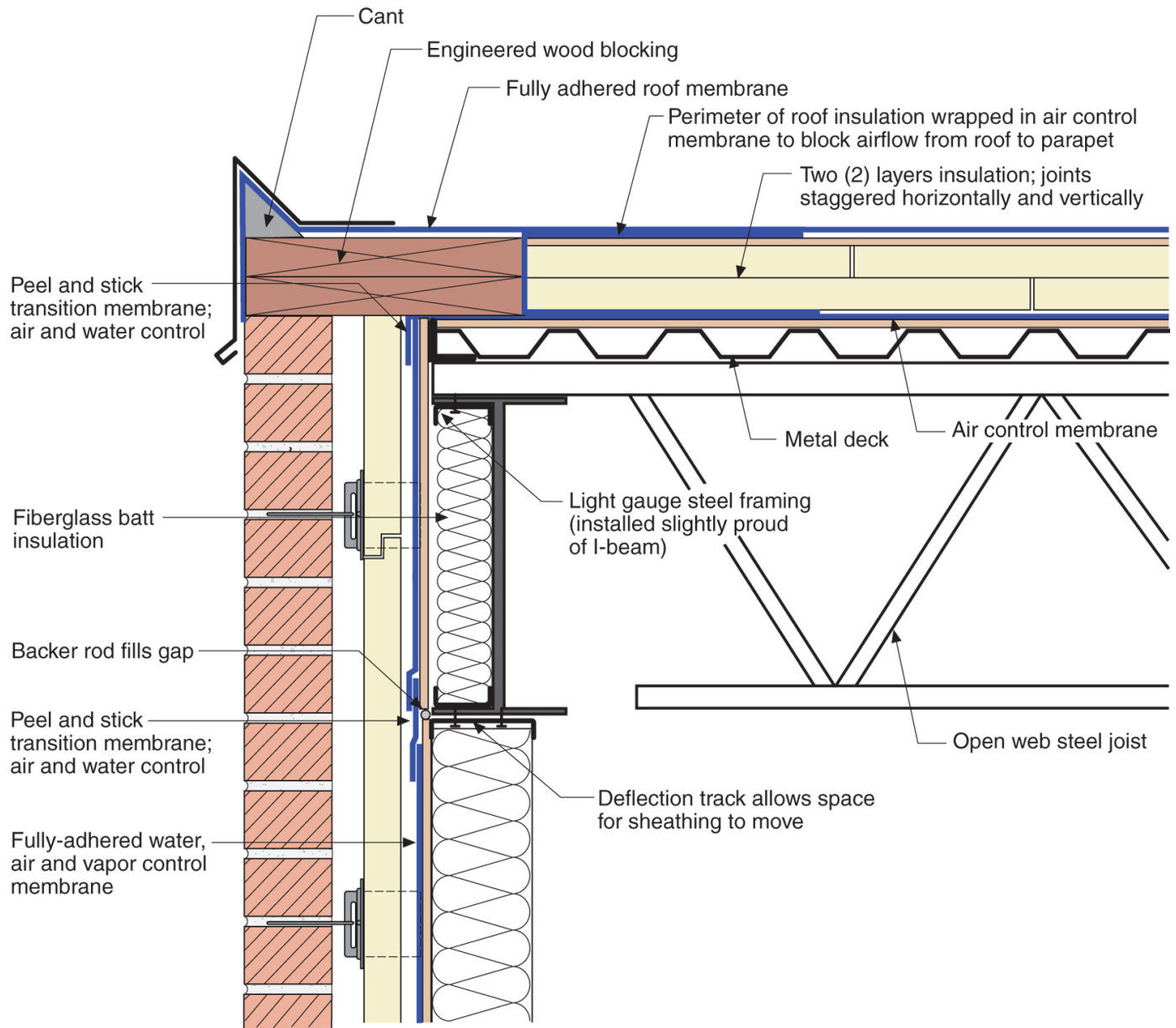


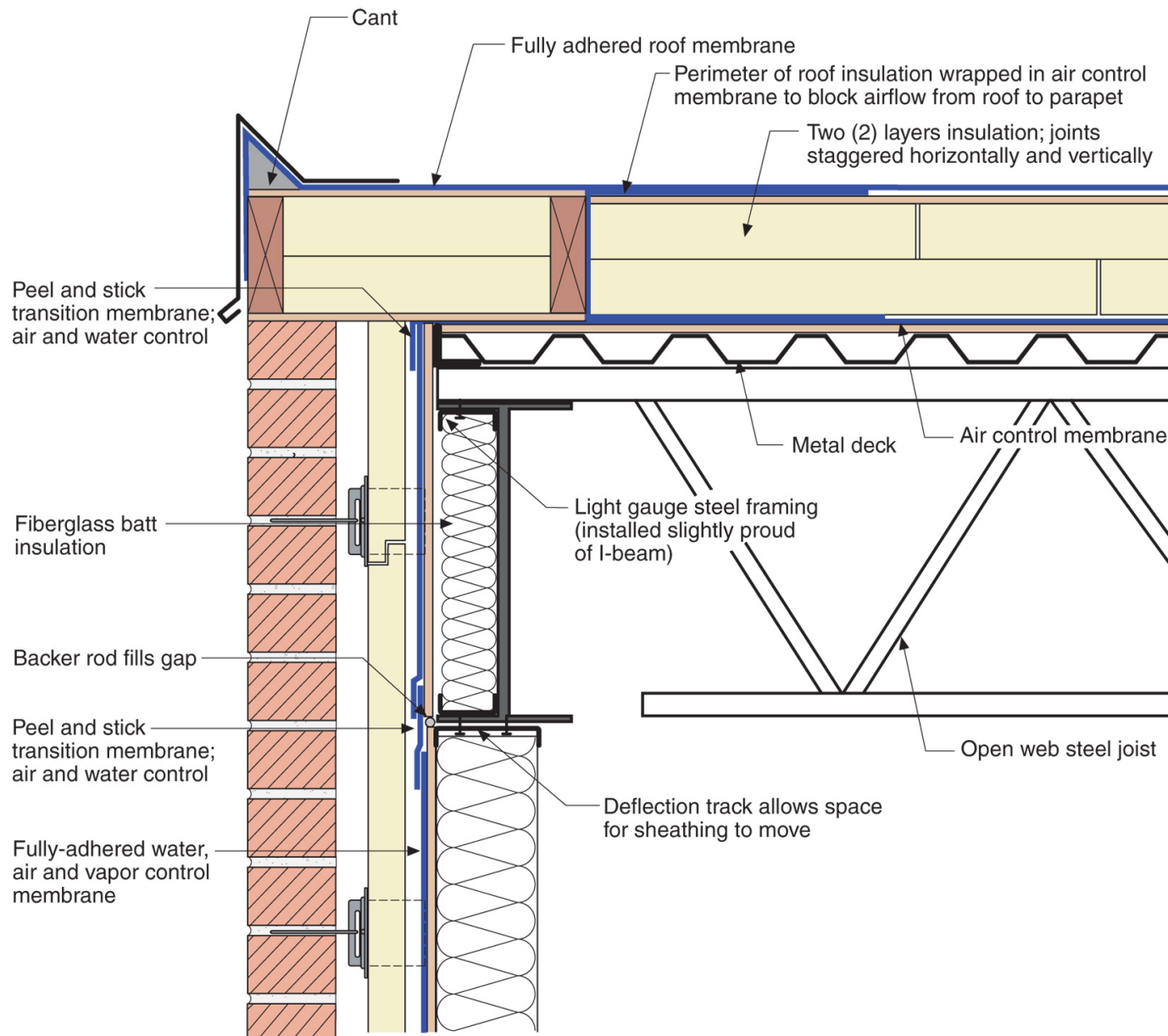


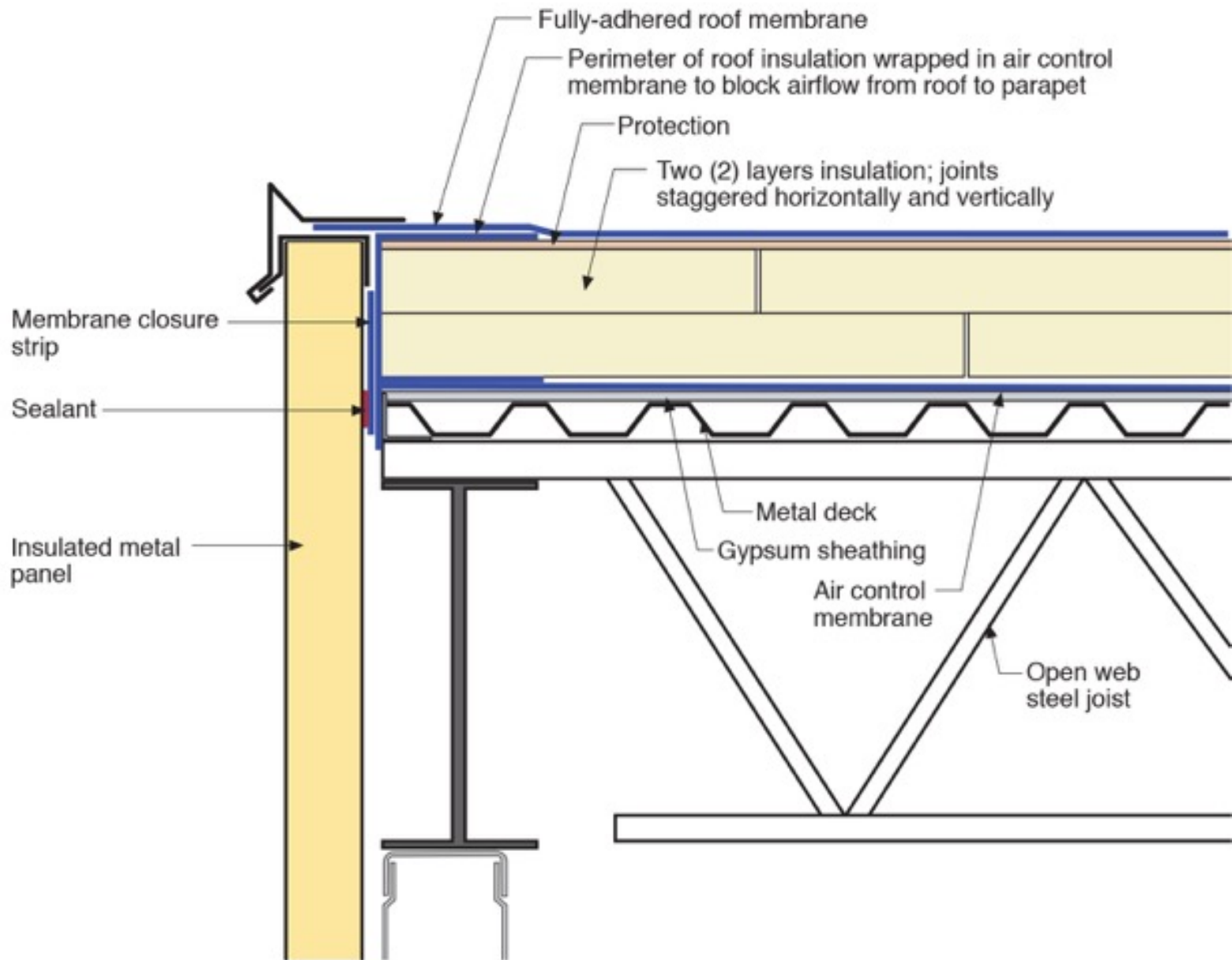












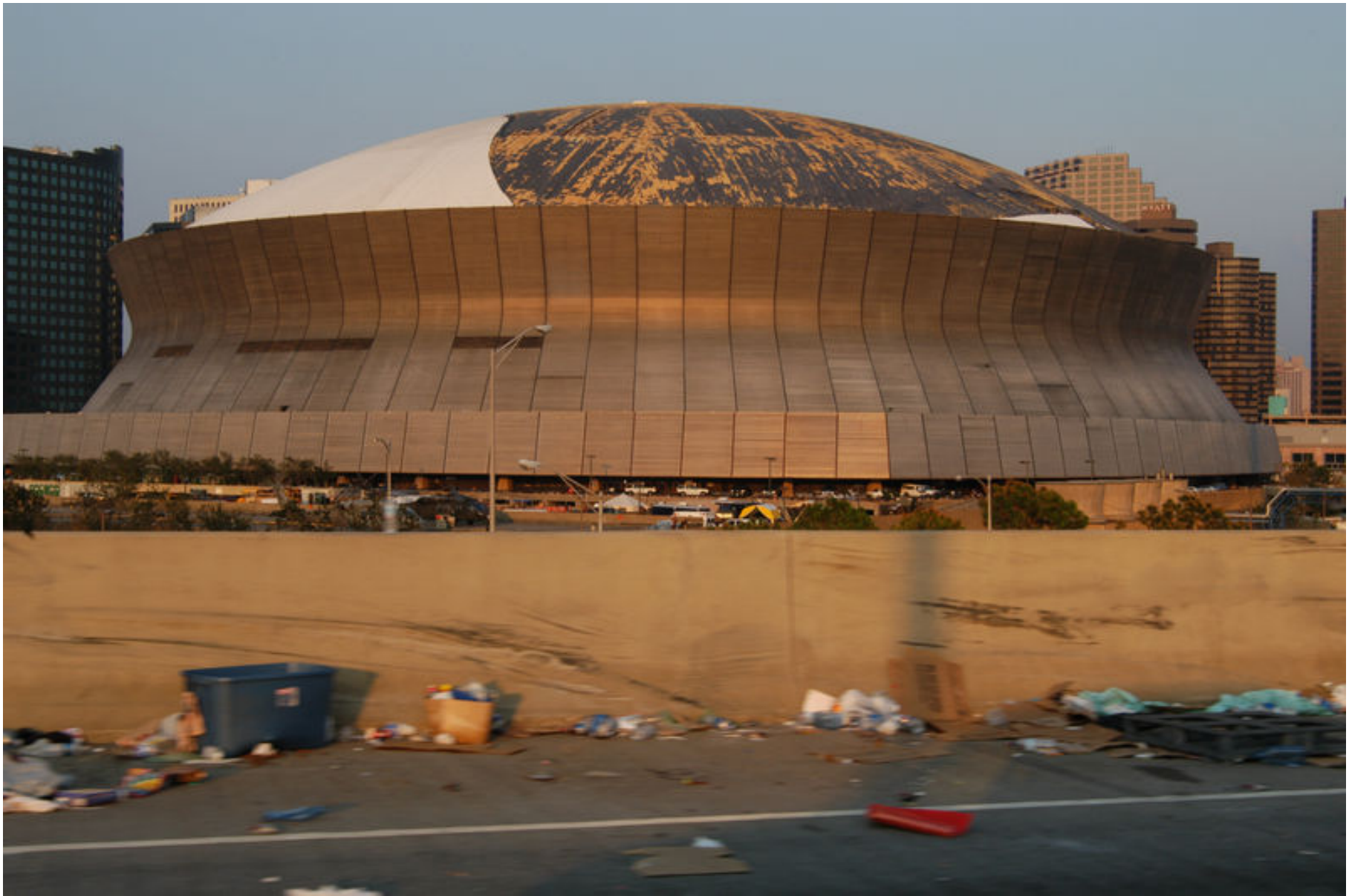
It's a Case of Black or White

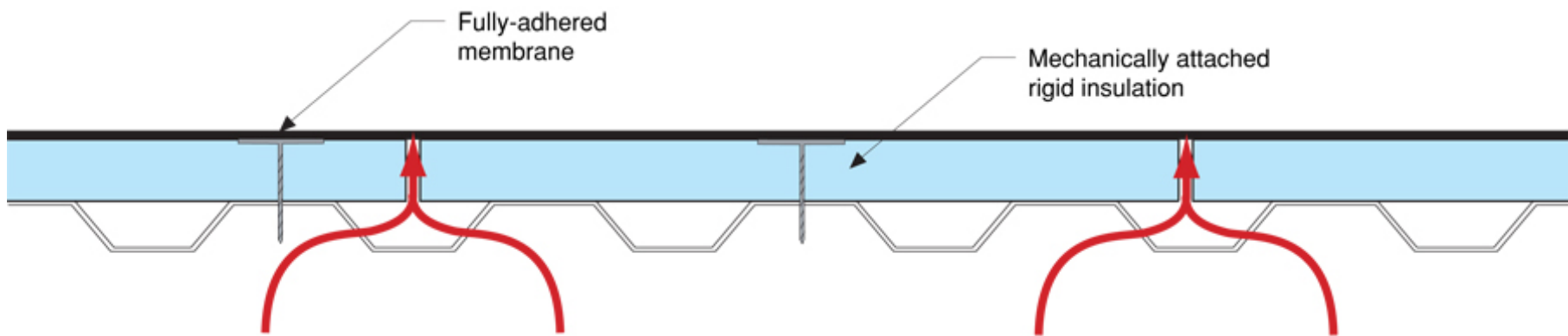
It's a Case of Black or White Arrhenius

It's a Case of Black or White

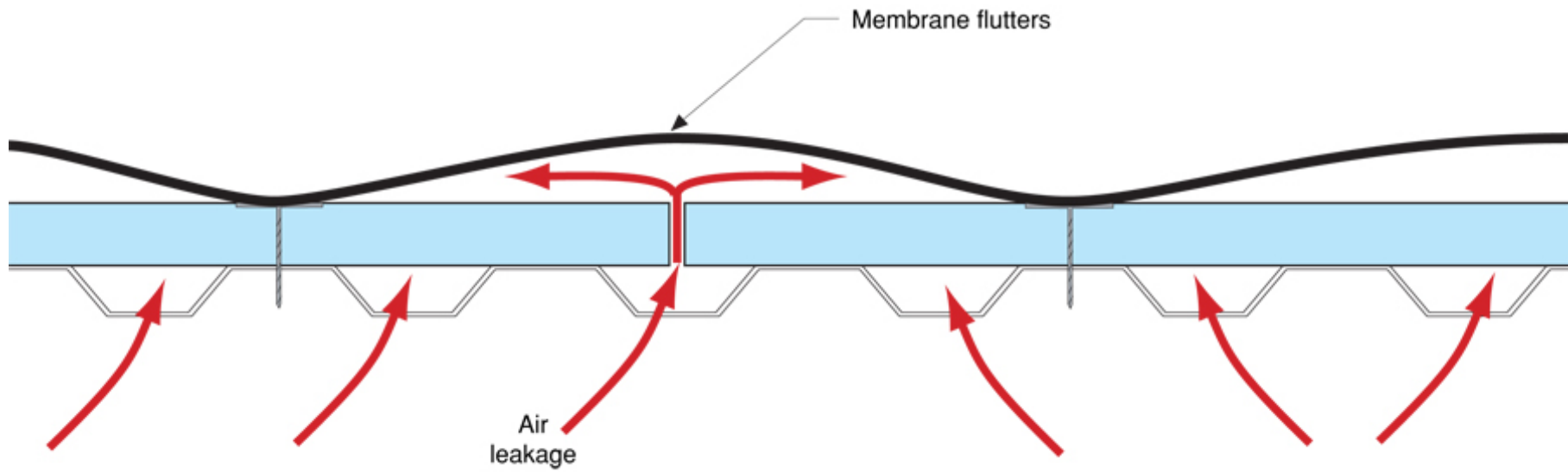
Arrhenius

Every 10 degrees C – double the “badness”



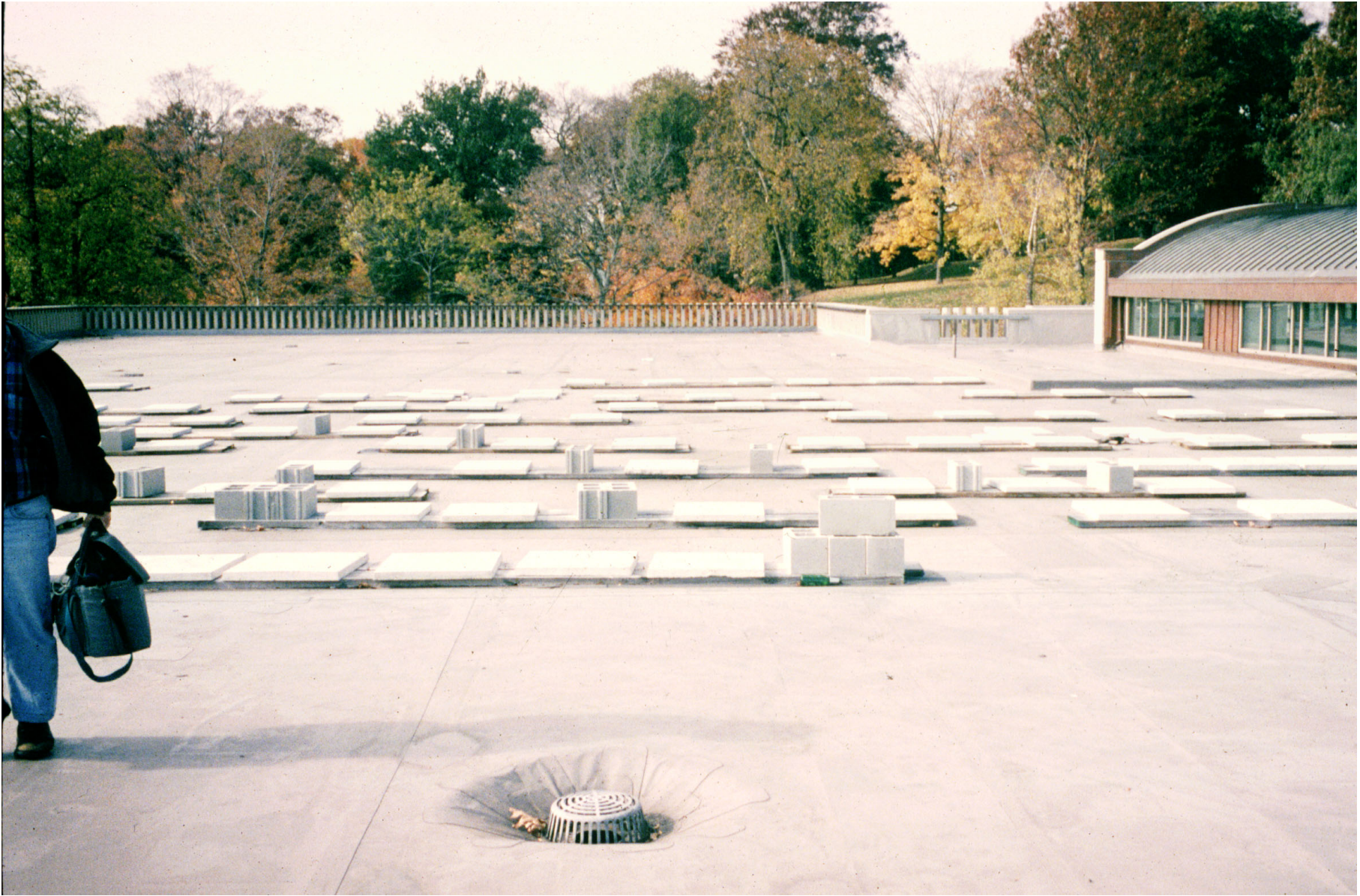




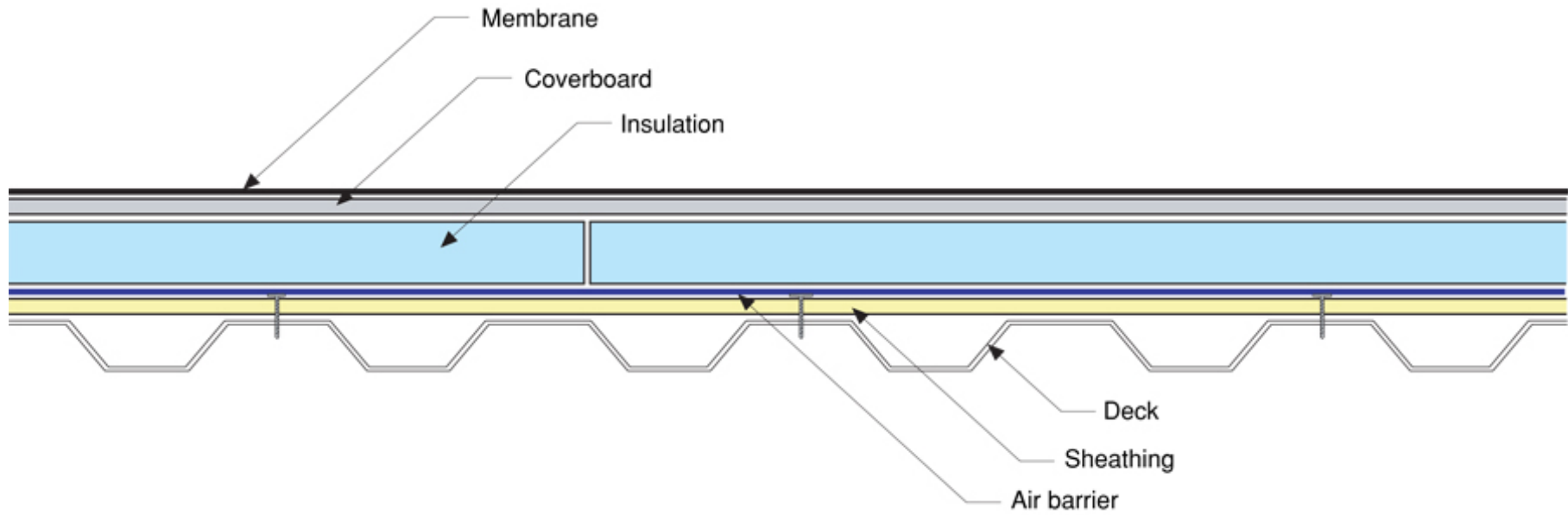


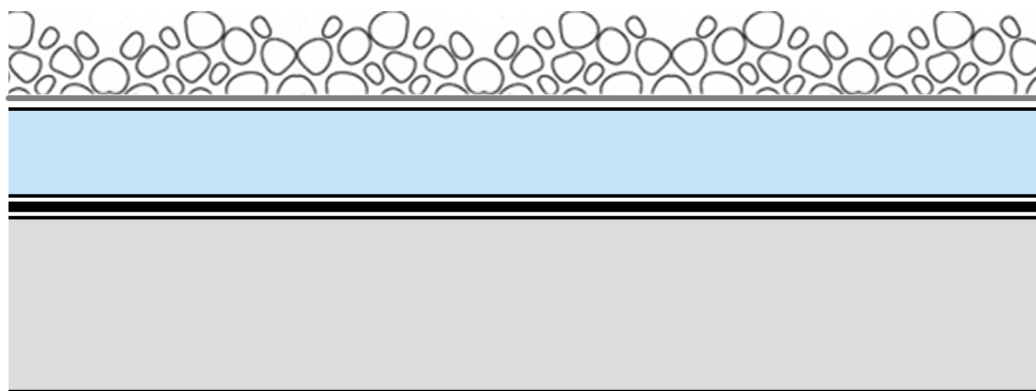




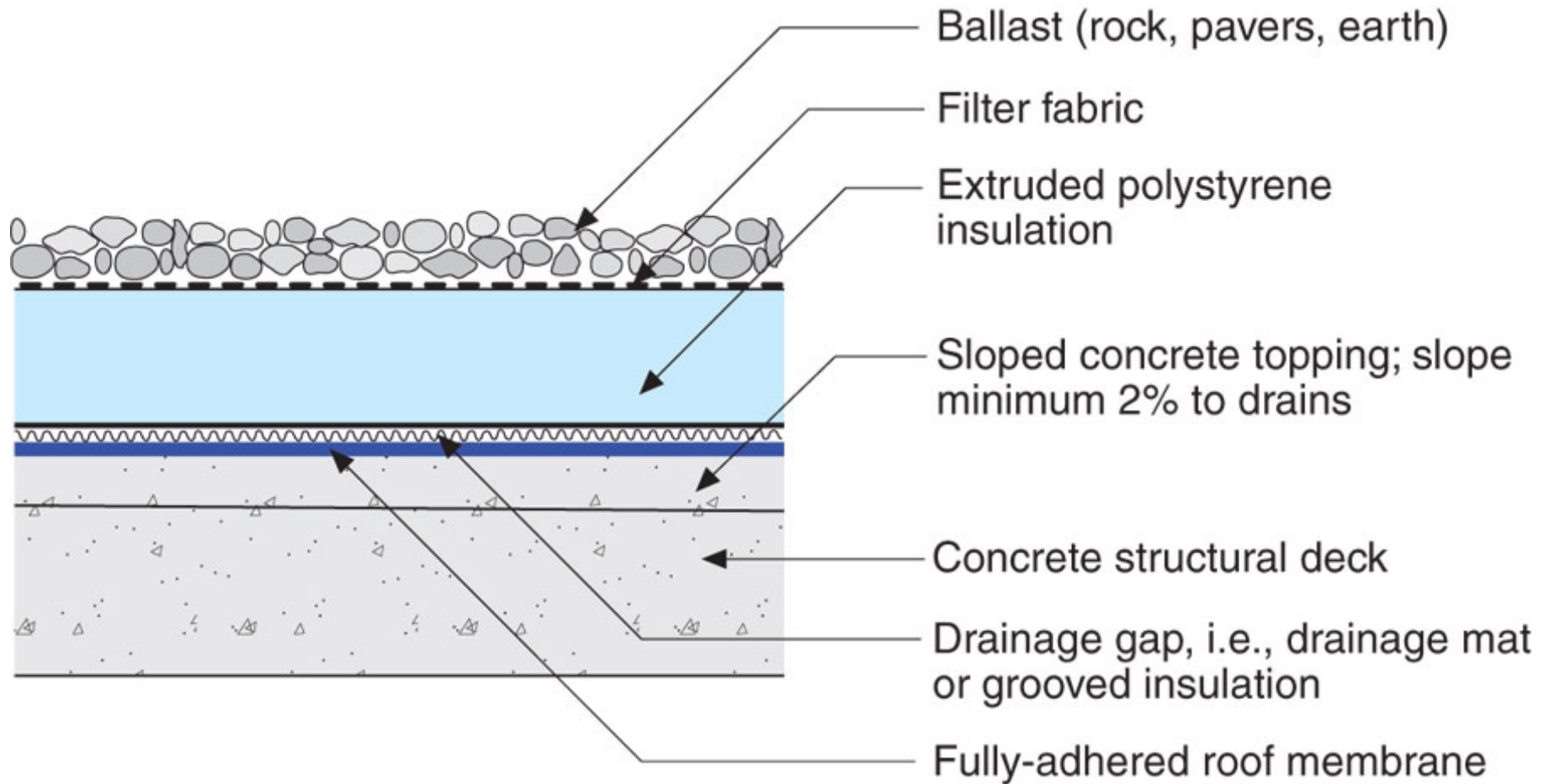


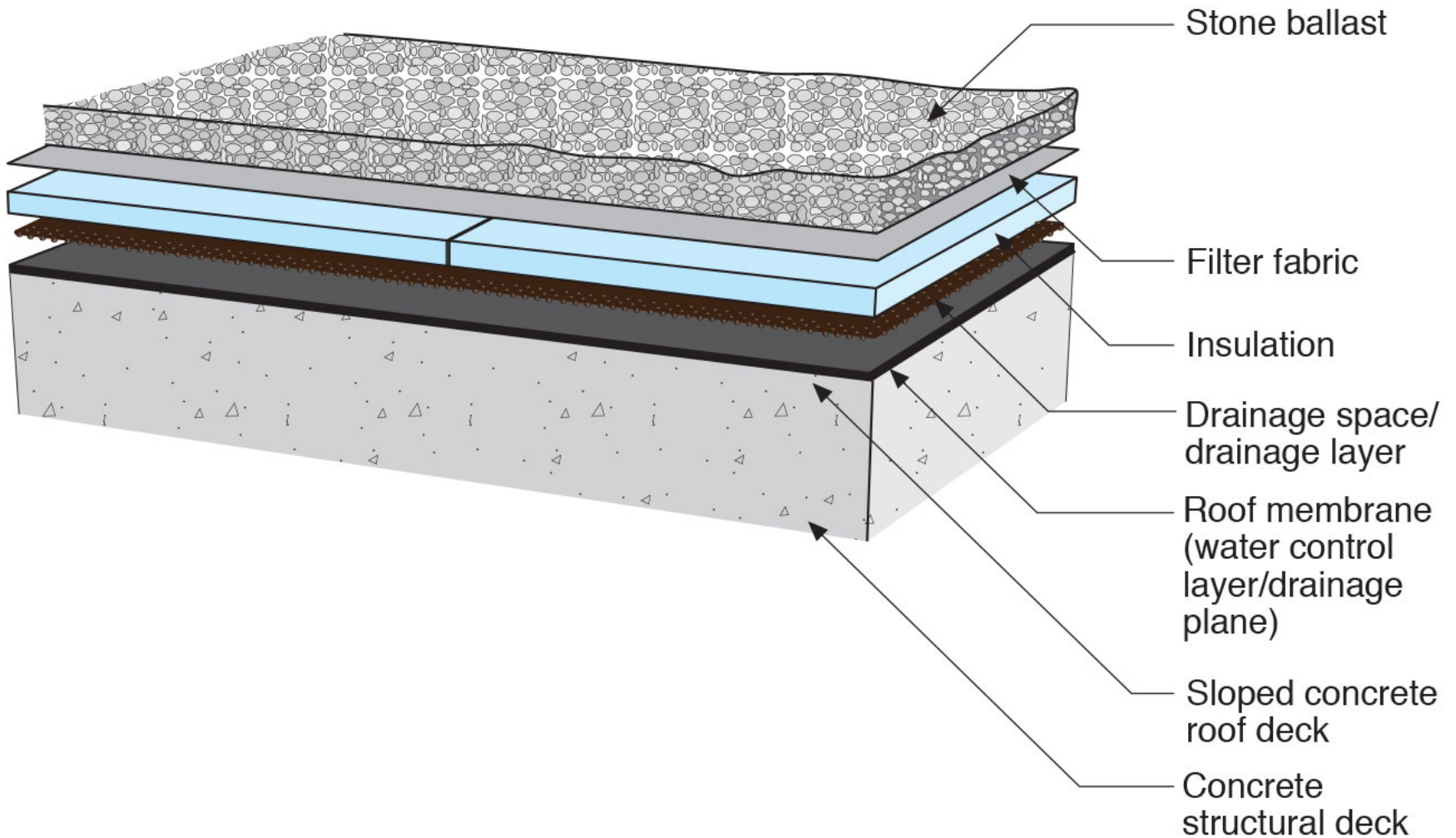


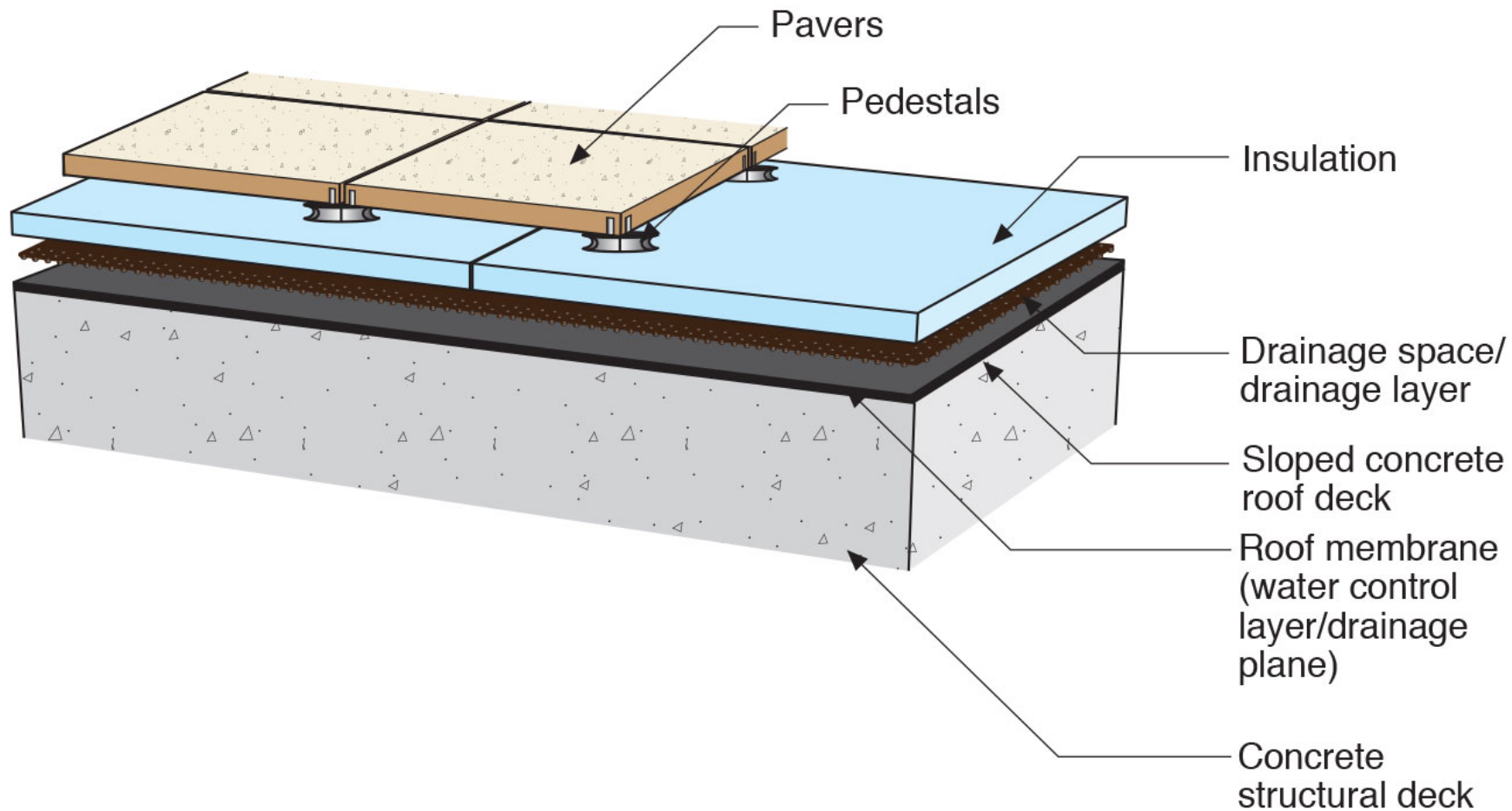


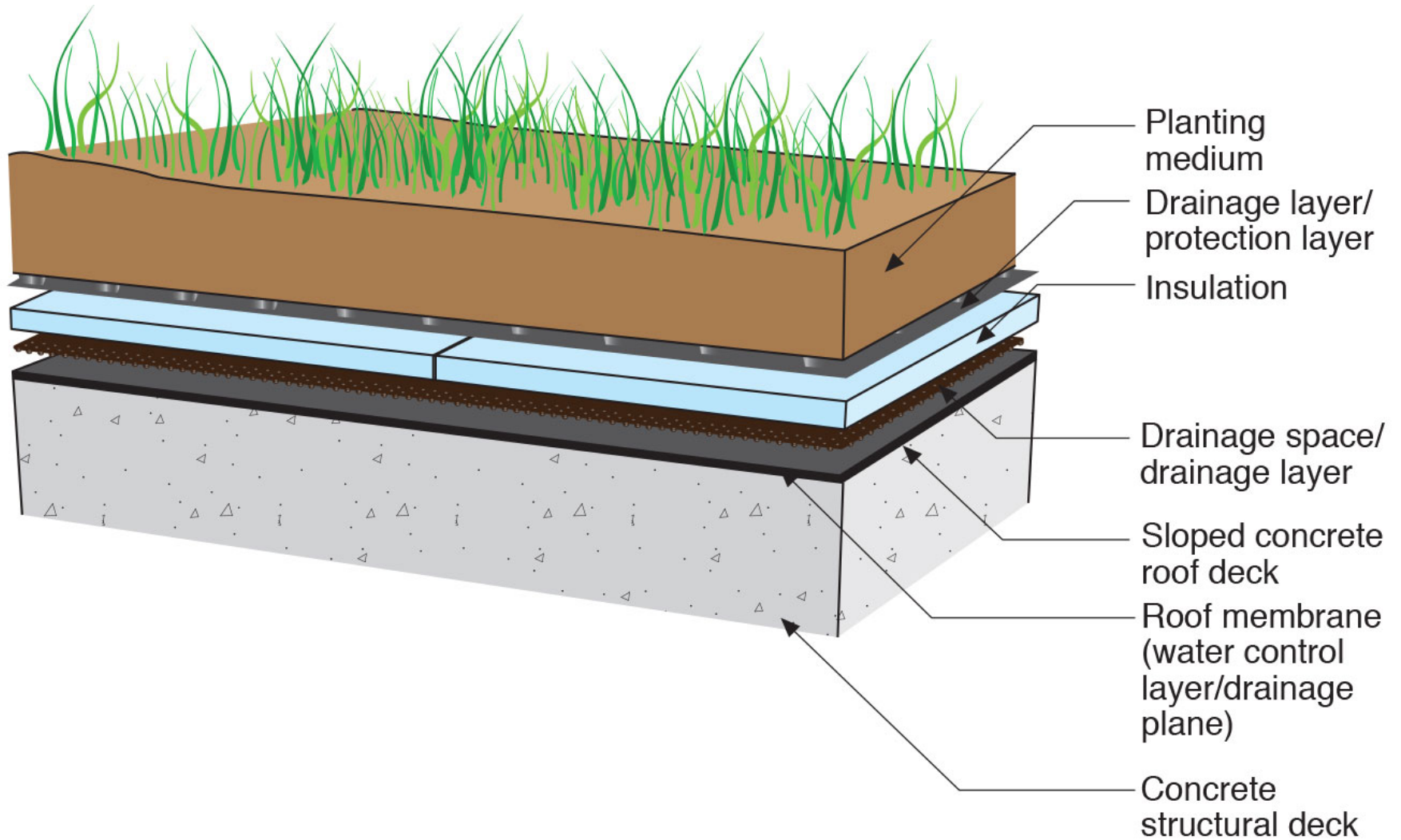


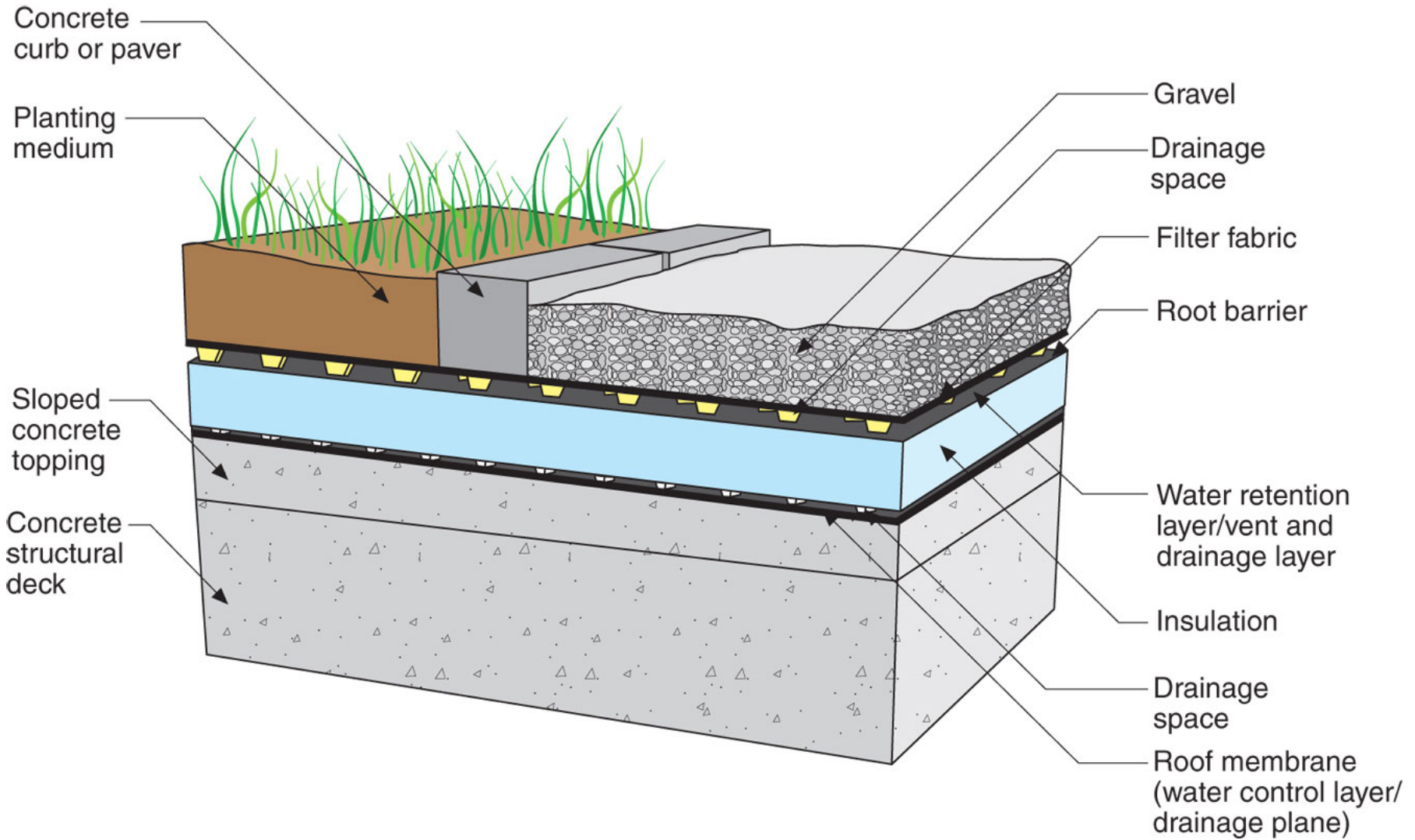
- ← Ballast
- ← Filter fabric
- ← Control layers
- ← Roof structure

















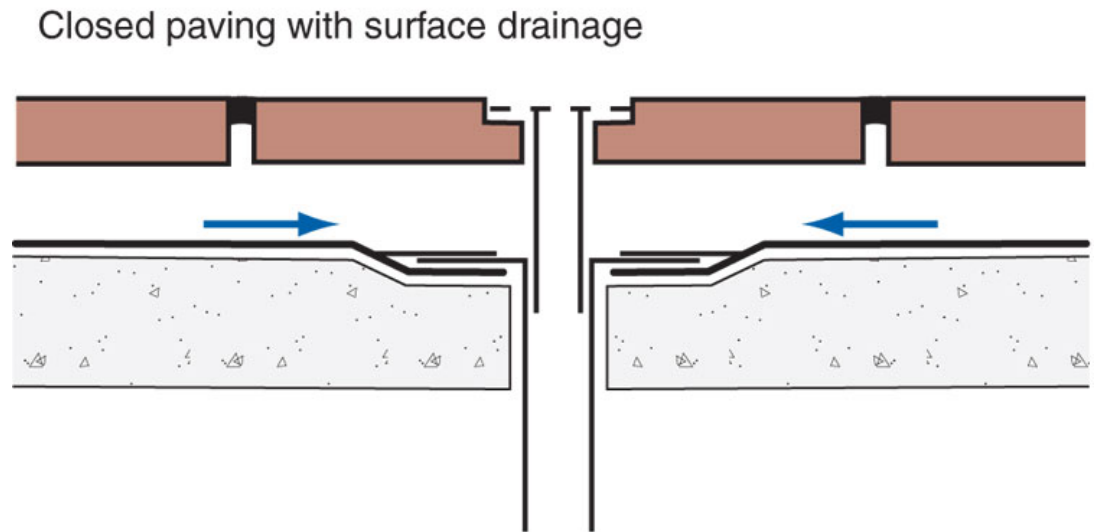
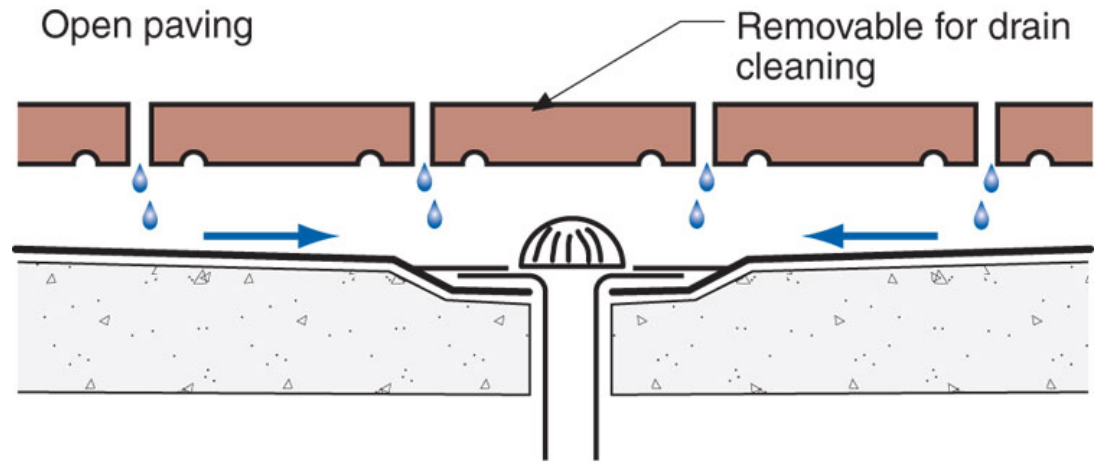




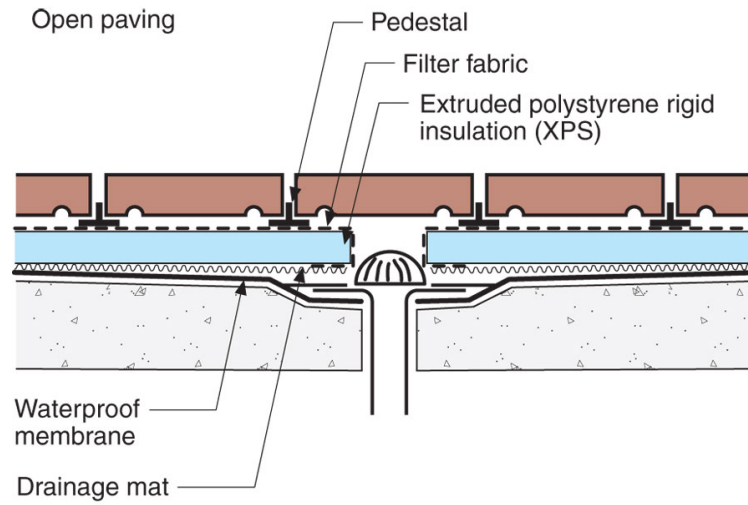


Plaza Decks

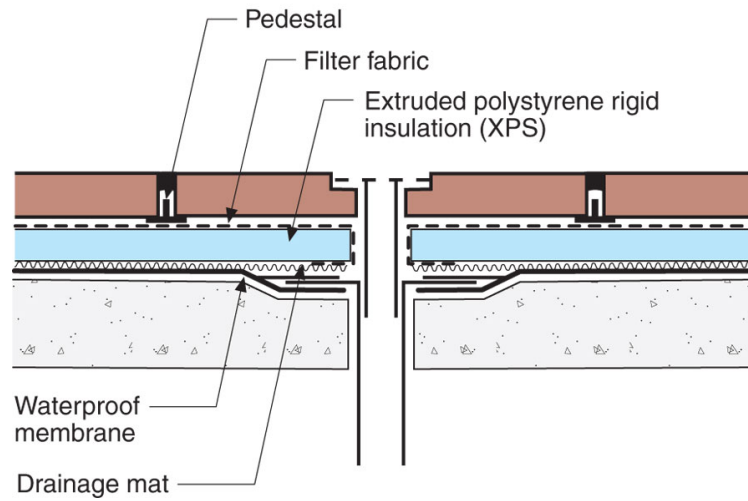




*From Baker, M.; Roofs, 1980
 Courtesy National Research Council of Canada*



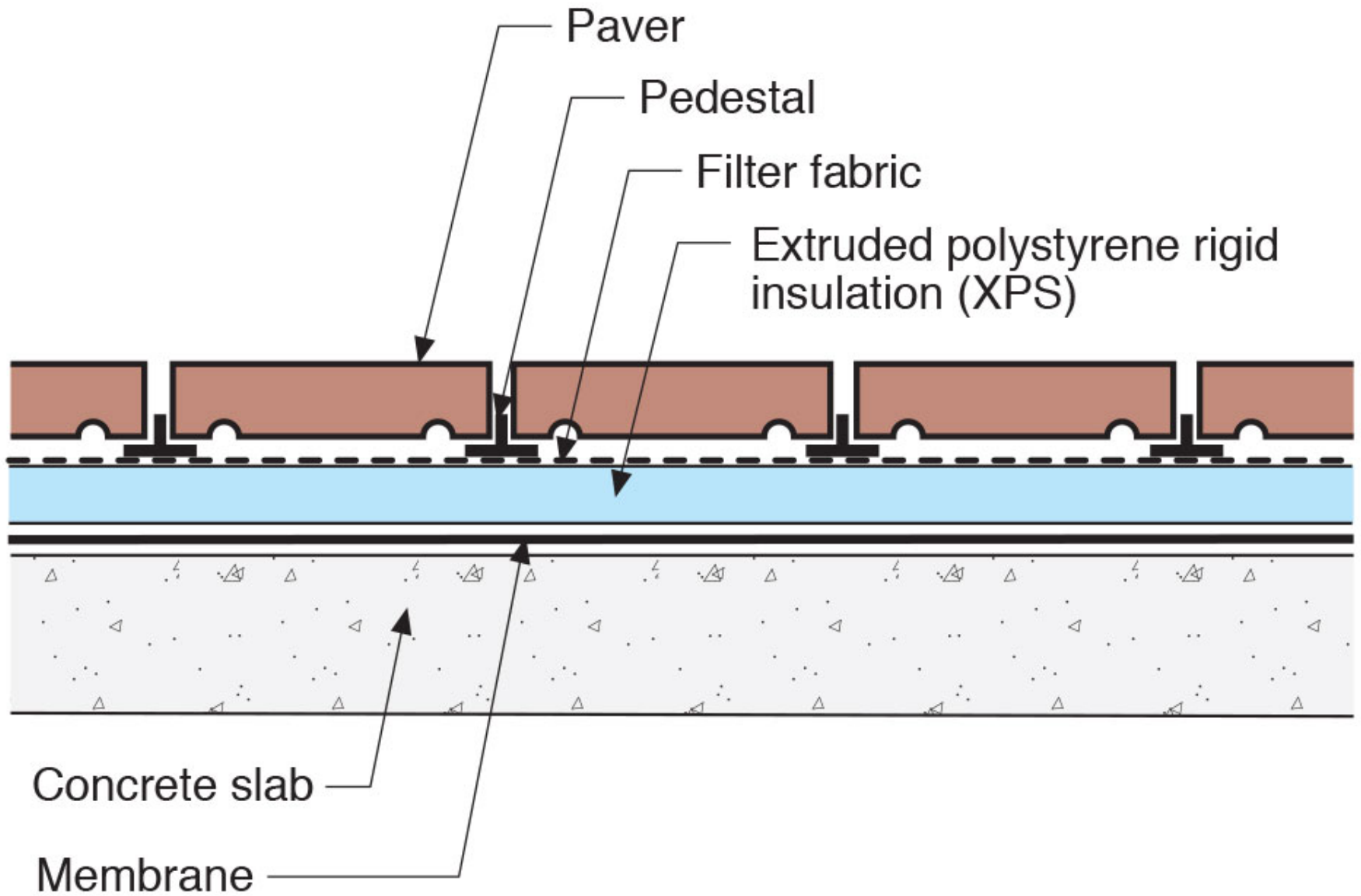
Closed paving with surface drainage

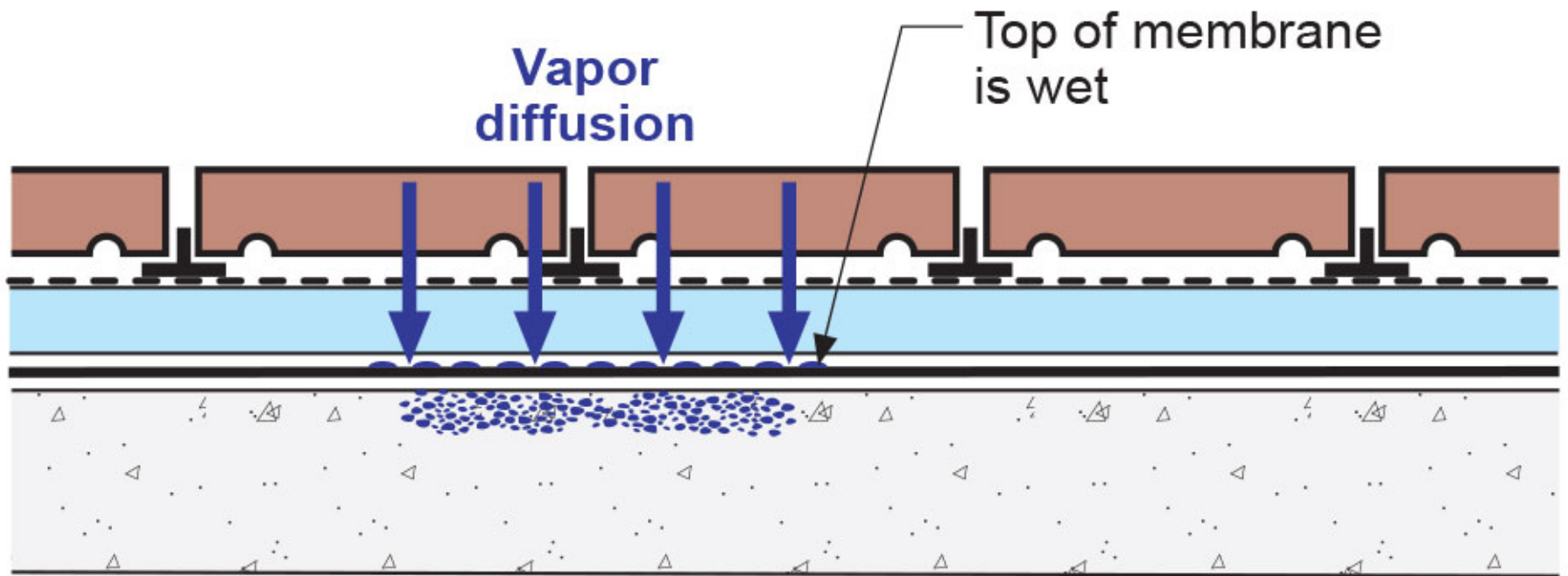




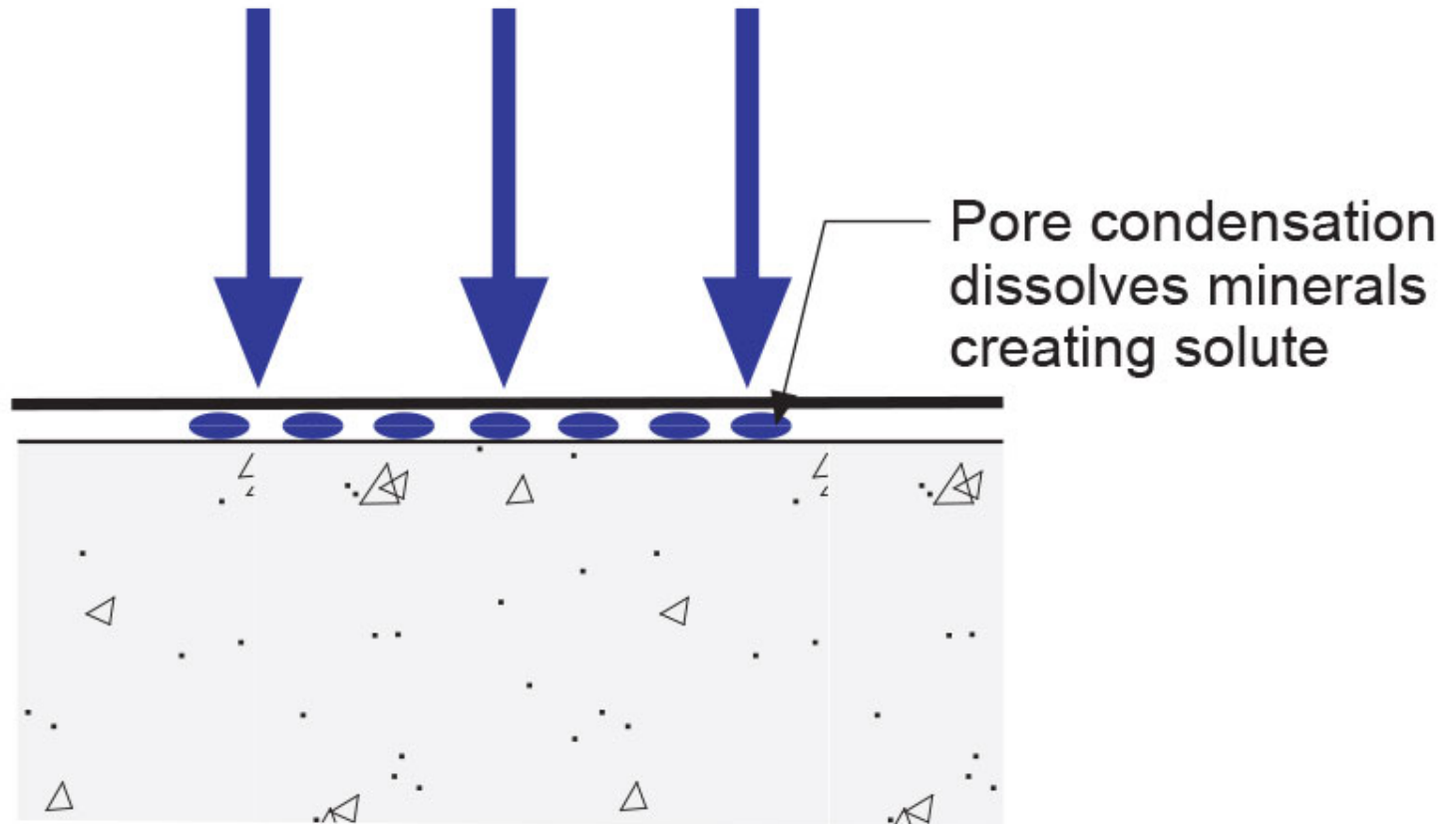


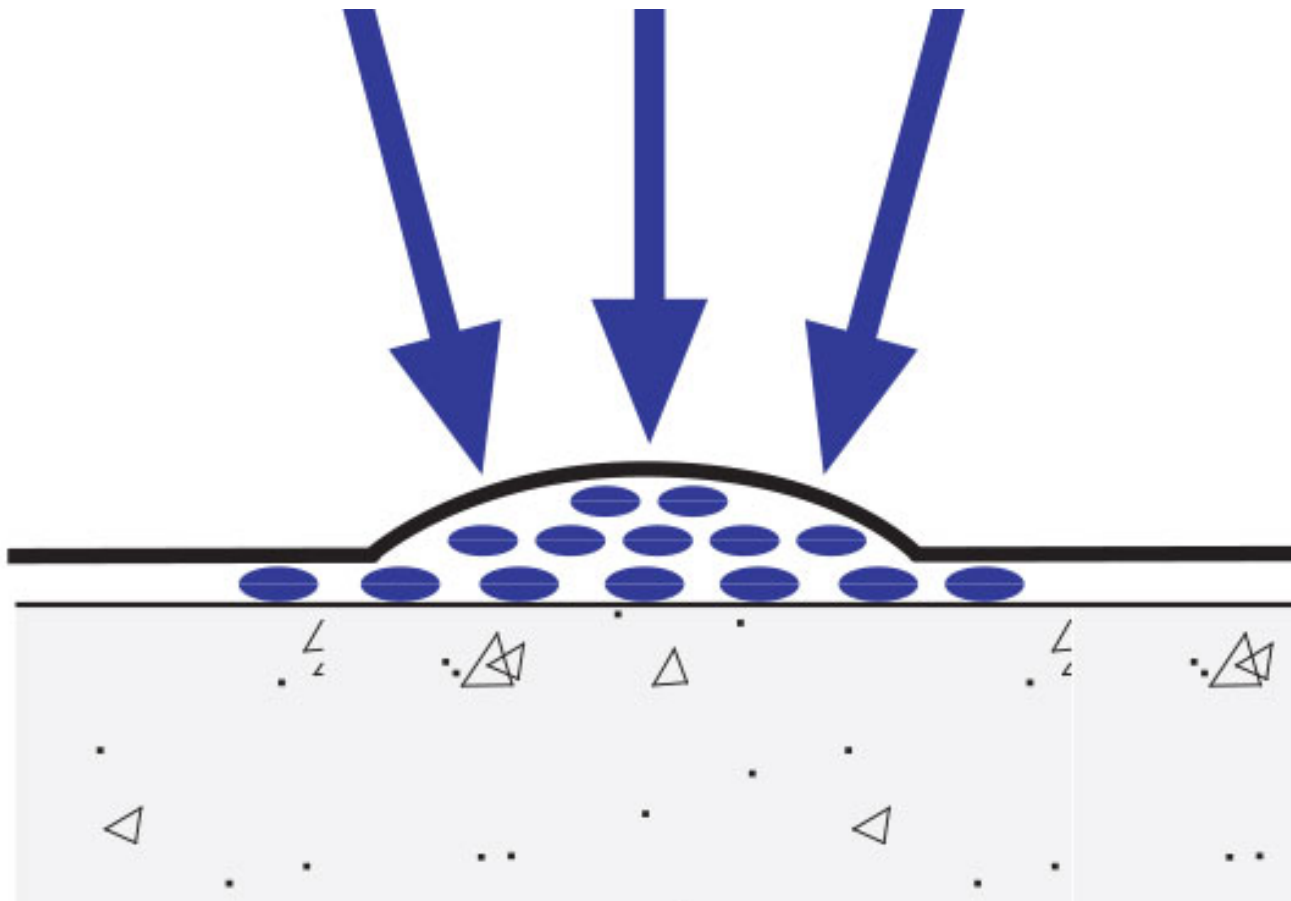
Osmosis





Vapor diffusion

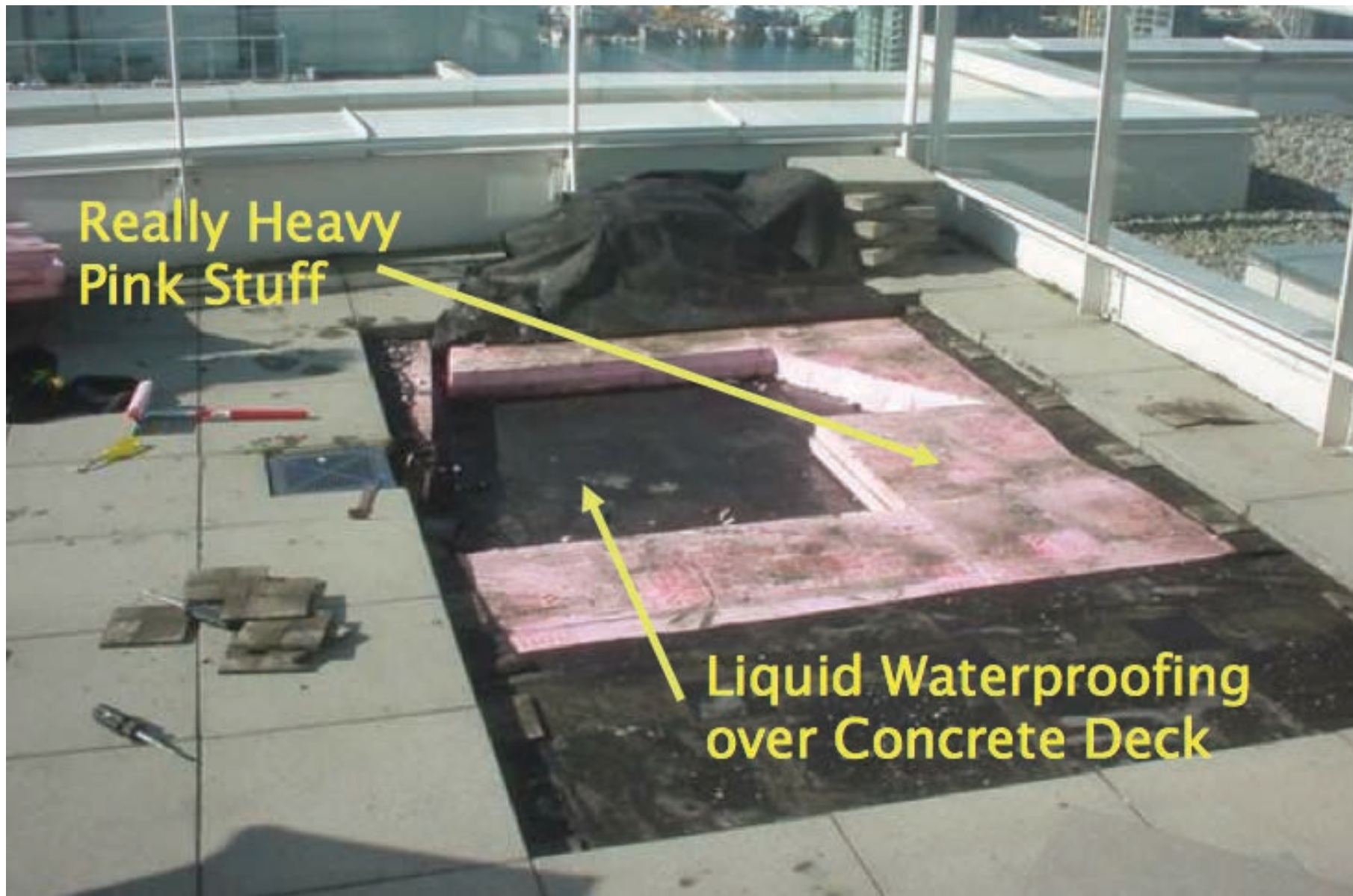






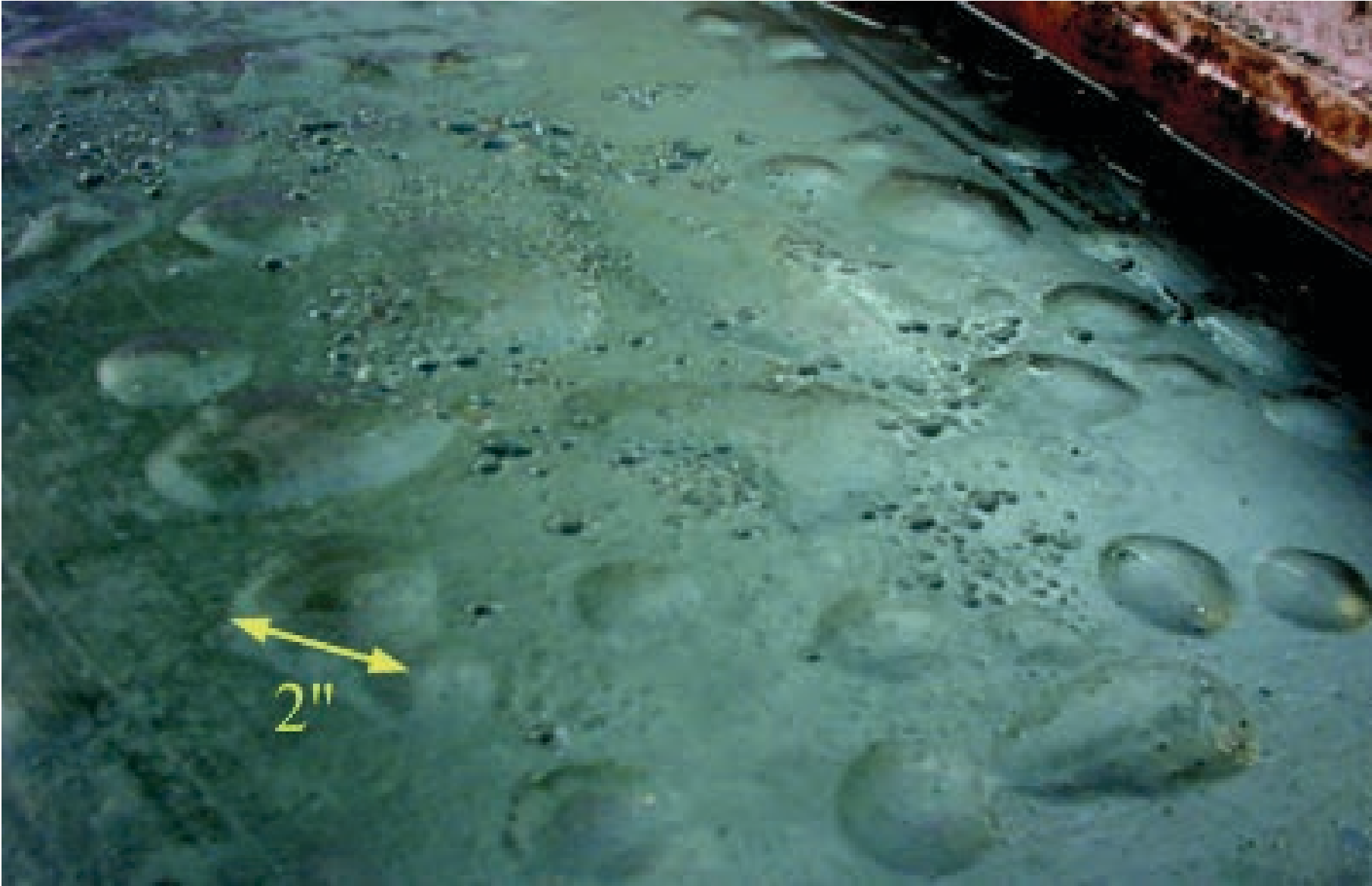
Paver Water Beds!





Really Heavy
Pink Stuff

Liquid Waterproofing
over Concrete Deck





VAPOR PERMEANCE OF LIQUID MEMBRANES

