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Building Science

Adventures In Building Science

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Control layer

Control layer

Roof structure
Building Science Corporation

Joseph Lstiburek

Air Temperature
-22 to 50°F (-30 to 10°C)

Winter

Summer

Sun

Wind

Air Temperature
50 to 104°F (10 to 40°C)

Rain

Roof Temperature
-40°F (-40°C)

Snow

Vapor

Heat Loss

Temperature
68 - 77°F (20 - 25°C)

Air Leakage

Cooling

Air Leakage

Temperature
68 - 77°F (20 - 25°C)

Traffic

Adapted from Baker, M.; Roofs, 1980; Courtesy National Research Council of Canada
Streamlines pushed up further by roof

Pressure

Pressure

Suction

Suction

Suction

Suction

Separation of flow at eaves causes high suction

Steeply sloped roof

Low sloped roof
No wind

Wind

Effect of shelter

Unbalanced load

Wind

Wind or no wind

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.

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
Gravel

Bitumen top pour

Felt

Bitumen

Felt

Bitumen saturated felt laid dry and nailed to deck

Dry sheathing or rosin paper nailed to deck

Wood deck

Two layers of rigid insulation; joints offset

Wood cant adhered to insulation with asphalt

Built-up roofing

Metal flashing

Wood blocking fixed to face brick

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.
Mass wall

Gravel surface

Roofing membrane

Air control layer turned up over edge of insulation and wood blocking and returned

2x4 wood blocking

Insulation

Air control layer

Adapted from Baker, M. Roofs, 1980
Membrane (water control layer, air control layer, vapor control layer)

Protection board

Thermal control layer

Membrane (air control layer and vapor control layer)

Gypsum board

Metal deck
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.
Parapet flashing

Tapered rigid insulation

Grout and reinforce parapet CMU as per structural requirements

Cant

Wood blocking

Perimeter of roof insulation wrapped in air control membrane to block airflow from roof to parapet

Fully adhered roof membrane

Two (2) layers insulation; joints staggered horizontally and vertically

Fully-adhered water, air and vapor control membrane

Peel and stick transition membrane; air and water control

Deflection space

Backer rod to fill deflection joint and debond water and air barrier
Parapet flashing

Fully-adhered water control membrane

Tapered rigid insulation

Air control layer transition membrane

Fiberglass batt insulation

Wood blocking

Perimeter of roof insulation wrapped in air control membrane to block airflow from roof to parapet

Fully adhered roof membrane

Two (2) layers insulation; joints staggered horizontally and vertically

Cant

Metal deck

Air control membrane

Light gauge steel framing (installed slightly proud of I-beam)

Deflection track allows space for sheathing to move

Open web steel joist

Backer rod fills gap

Peel and stick transition membrane; air and water control

Water, air and vapor control membrane; preferably fully-adhered
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 (rock, pavers, earth)
Filter fabric
Extruded polystyrene insulation
Sloped concrete topping; slope minimum 2% to drains
Concrete structural deck
Drainage gap, i.e., drainage mat or grooved insulation
Fully-adhered roof membrane
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- Pavers
- Pedestals
- Insulation
- Drainage space/drainage layer
- Sloped concrete roof deck
- Roof membrane (water control layer/drainage plane)
- Concrete structural deck
Plaza Decks
Open paving

Closed paving with surface drainage

From Baker, M.; Roofs, 1980
Courtesy National Research Council of Canada
Osmosis
Vapor diffusion

Top of membrane is wet
Vapor diffusion

Pore condensation dissolves minerals creating solute
Paver Water Beds!
Really Heavy Pink Stuff

Liquid Waterproofing over Concrete Deck