Ballast

Filter fabric

Control layers

Roof structure
Control layer
Control layer
Roof structure
Air Temperature
-22 to 50°F
(-30 to 10°C)

Winter
Summer

Wind

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

Rain

Snow

Roof Temperature
-40°F
(-40°C)

Roof Temperature
194°F
(90°C)

Traffic

Water

Vapor

Heat Loss

Temperature
68 - 77°F (20 - 25°C)

Air Leakage

 Cooling

Temperature
68 - 77°F (20 - 25°C)

Air Leakage

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

Pressure

Suction

Steeply sloped roof

Separation of flow at eaves causes high suction

Pressure

Suction

Suction

Low sloped roof
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 Leutheusser, H.J.; 1964; Courtesy University of Toronto
Low uplift

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

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

High uplift

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
From Baker, M.; Roofs, 1980
Hours of a winter day

From Baker, M.; Roofs, 1980
Building Science Corporation

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

From Baker, M.; Roofs, 1980
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
Approx. 1/2" gap

Maximum 12' length each piece of perimeter flashing

Fasten base flashing approx. 8"

Wood cant fastened to engineered wood blocking

Engineered wood blocking

1" below blocking

Continuous cleat

Sheet metal joint cover plate set in two beads of sealant

High-domed, capped, gasketed fasteners

Extend membrane base flashing approx. 4" beyond toe of cant

Multi-ply membrane base flashing

Perimeter of roof insulation wrapped in air control membrane

Multi-ply built-up roof membrane

Coverboard insulation

Thermal insulation

Concrete deck
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

Vapor Profile
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

Fully-adhered water control membrane

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

Peel and stick transition membrane; air and water control

Deflection space

Backer rod to fill deflection joint and debond water and air barrier
Cant
Engineered wood blocking
Fully adhered roof membrane
Perimeter of roof insulation wrapped in air control membrane to block airflow from roof to parapet
Two (2) layers insulation; joints staggered horizontally and vertically

Peel and stick transition membrane; air and water control
Fiberglass batt insulation
Backer rod fills gap
Peel and stick transition membrane; air and water control
Fully-adhered water, air and vapor control membrane

Metal deck
Air control membrane
Light gauge steel framing (installed slightly proud of I-beam)
Open web steel joist
Deflection track allows space for sheathing to move
1. Fully-adhered roof membrane
2. Perimeter of roof insulation wrapped in air control membrane to block airflow from roof to parapet
3. Protection
4. Two (2) layers insulation; joints staggered horizontally and vertically
5. Membrane closure strip
6. Sealant
7. Insulated metal panel
8. Metal deck
9. Gypsum sheathing
10. Air control membrane
11. Open web steel joist
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
Plaza Decks
Open paving

Removable for drain cleaning

Closed paving with surface drainage

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

Pedestal
Filter fabric
Extruded polystyrene rigid insulation (XPS)

Waterproof membrane
Drainage mat

Closed paving with surface drainage

Pedestal
Filter fabric
Extruded polystyrene rigid insulation (XPS)

Waterproof membrane
Drainage mat
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
VAPOR PERMEANCE OF LIQUID MEMBRANES

- Aged Membrane 1 - 30 mils
- Aged Membrane 2 - 60 mils
- New Membrane 3 - 120 mils
- SBS/Hot Rubber

VAPOR PERMEANCE - US PERMS

DRY CUP  WET CUP  INVERTED WET CUP