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## Understanding Low-Slope Roofing

## Learning Objectives



At the completion of this course, participants will be able to:

- Successfully identify different types of roof assemblies used in today's architecture
- Understand and communicate the role of an insulated roofing system in the building envelope with respect to comfort, performance and durability of the building
- Identify contemporary typical insulated roof systems
- Describe the advantages and disadvantages of the different types of components used in an insulated roof system
- List the components of an insulated roof system

## Contents

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- Types of roofs
- Functions of a roof
  - Typical loads on roof system
- Types of roof systems
  - Warm structural deck with the membrane exposed
  - Warm structural deck with the membrane protected
  - Cold structural deck with the membrane exposed
- Components of an insulated roof system
  - Membrane types
  - Insulation types
  - Vapour retarder types
  - Decking types

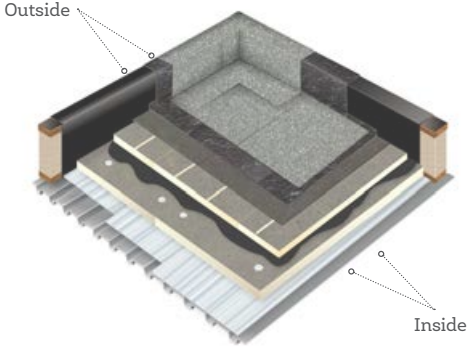
# Types of Roofs

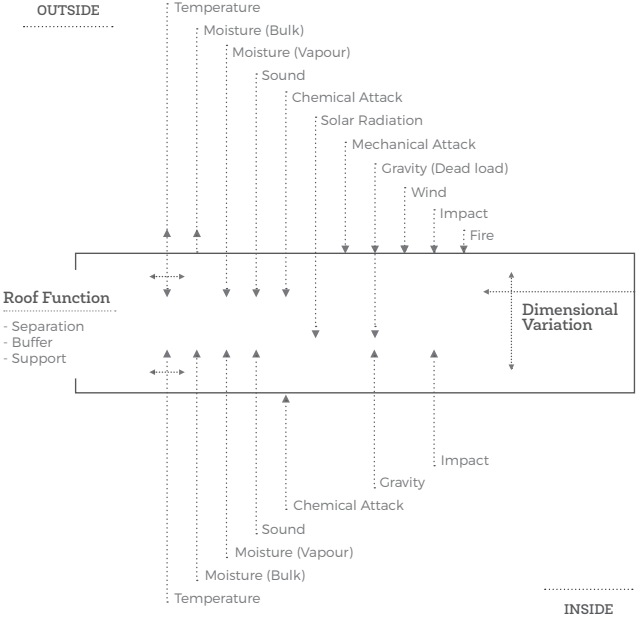
- Two dominant types of roofs
  - Sloped and water-shedding roofs
  - Flat or low-slope roofs containing a continuous waterproof membrane
- Flat or low-slope roofs containing a continuous waterproof membrane are addressed in this presentation

# Function of a Roof



- Loadings originate inside and outside the building as well as from the roof itself
- The effects of the loads must be considered and minimized in a well designed roof system



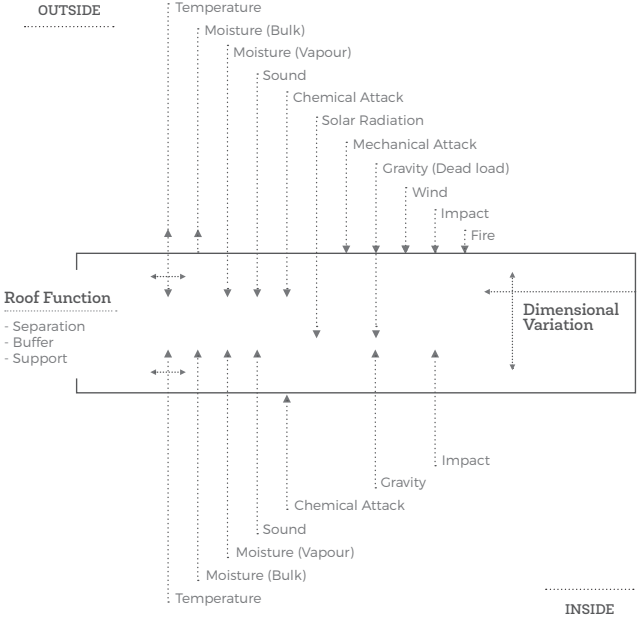



# Typical Loads on a Roof System



Outside loads

- Temperature differential
- Moisture (bulk and vapour)
- Sound
- Chemical
- Solar radiation
- Mechanical
- Gravity
- Wind
- Fire
- Dead loads
- Live loads (Con't)

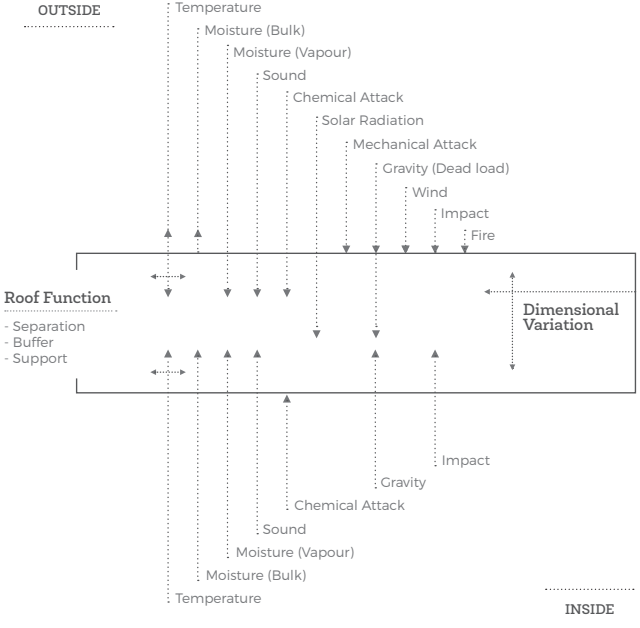


# Typical Loads on a Roof System



Inside loads

- Temperature
- Moisture (bulk and vapour)
- Sound



# Types of Insulated Roof Systems

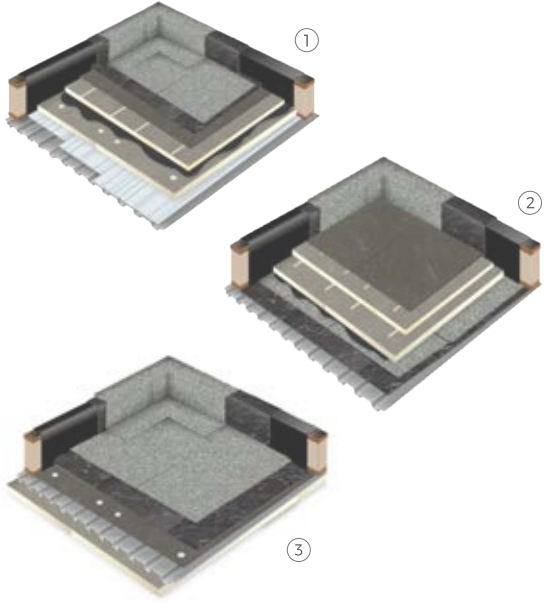


- Older roofs may or may not contain insulation. Contemporary roof systems however, include a thermal insulation layer and are the only systems considered in this presentation.

- Divided into three main types:
  ① Warm structural deck with the membrane exposed
  ② Warm structural deck with the membrane protected
  ③ Cold structural deck with the membrane exposed

- The location of the thermal insulation makes a significant difference to the design of a roof system.

- Interior environment buffered from variable exterior climate by roof system.



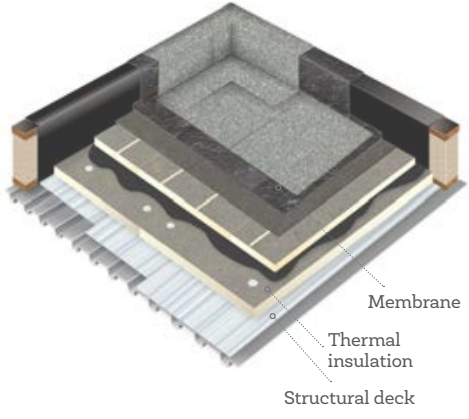
# Warm Structural Deck with Membrane Exposed



- A roof system featuring a warm structural deck with an exposed membrane is constructed from the inside to the outside as follows:
  • Structural deck ···▸Thermal insulation ···▸Membrane

- In this system the structural deck is buffered from the variable exterior climate and kept warm during the heating season.

- The exposed membrane lies above both the deck and insulation taking the brunt of the environmental damage to the system.
  Often the membrane will be protected with a coating of some kind to protect against the sun.



# Warm Structural Deck with Membrane Protected

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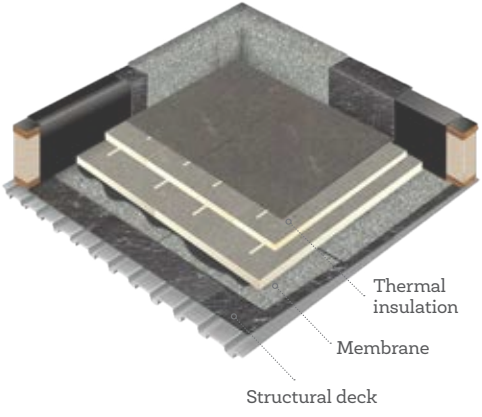
- Referred to as an inverted roof, this system type sandwiches the membrane between the structural deck and the thermal insulation. From the inside to the outside the deck would be constructed as follows:
  - Structural deck ···▸Membrane ···▸Thermal insulation
- In this system the membrane is protected from environmental damage by the thermal insulation layer
- In this system the structural deck is buffered from the variable exterior climate and kept warm during the heating season

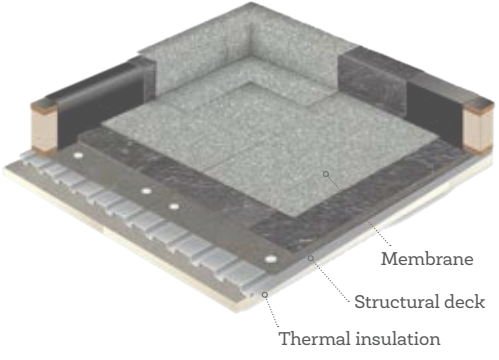


# Cold Deck with Exposed Membrane



- A roof system featuring a cold structural deck with an exposed membrane is constructed from the inside to the outside as follows:
  - Thermal insulation ···▸Structural deck ···▸Membrane

- In this type of insulated system the insulation lies below the structural deck buffering interior temperature from the variable outdoor environment leaving the deck exposed to the same thermal loading as the membrane



# Components of an Insulated Roof System

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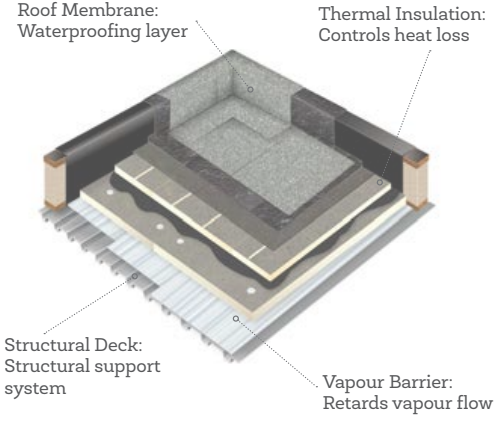
- The primary components of an insulated roof system are:
  - Roofing membrane: this is the waterproofing layer
  - Thermal insulation: used to control and minimize conductive heat loss
  - Vapour barrier: used to limit moisture movement into the assembly
  - Structural decking: structural support or surface for the membrane and other components



# Types of Roof Membranes

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- Common types of insulated roof system membranes are:
  - Built Up Roofing Membrane (**BUR**)
  - Modified Bitumen Membrane (**Mod-Bit**)
  - Ethylene-Propylene-Diene-Monomer (**EPDM**)
  - Polyvinyl Chloride (**PVC**)
  - Thermoplastic Polyolefin (**TPO**)

# Built Up Roof Membrane (BUR)



- This type of membrane consists of a series of interchanging asphalt and reinforcement layers
- There are three types of asphalt that are manufactured to meet the physical requirements related to the slope of the surface they are being applied to (Con't)

| ORGANIC FELT | FIBERGLASS FELT |
|---|---|
| Low moisture resistance | High moisture resistance |
| Very pliable | Brittle |
| Requires 4 plies | Required 2-3 plies |
| Low strength | High strength |

# Built Up Roof Membrane (BUR)



- Reinforcement typically consists of organic or fiberglass felt each with their own advantages and disadvantages

| ADVANTAGES OF BUR | DISADVANTAGES OF BUR |
|---|---|
| Time proven | Hot, messy, burn hazard |
| 15-20+ Year service life | Field applied |
| Low cost materials | Labour intensive |
| Water resistant | — |
| Chemical resistant | — |

# Modified Bitumen Membranes (Mod-Bit)



- Prefabricated sheets of membranes used to waterproof the system in a two-ply application

- There are two types of modified bitumen membranes:
  - Atactic Polypropelyn (**APP**): this type of membrane is typically more brittle at low temperatures and used in warm climates
  - Styrene Butadiene Styrene (**SBS**): this type of membrane is typically more flexible at low temperatures and used in cold climates

- Applied in variety of ways:
  - Heat welded
  - Hot mop applied
  - Cold adhesive applied (Con't)

# Modified Bitumen Membranes (Mod-Bit)



| ADVANTAGES OF MODIFIED BITUMEN | DISADVANTAGES OF MODIFIED BITUMEN |
|---|---|
| Excellent flexibility | Fire hazard when applying with heat |
| High strength | Poor solvent resistance |
| High puncture resistance | — |
| Excellent weathering | — |
| Variety of colours | — |
| Lightweight | — |

# Ethylene-Propylene-Diene-Monomer (EPDM) Membrane



- EPDM membranes are single-ply sheet membranes that are manufactured from a rubber polymer (**EPDM**) and carbon black.

- EPDM membranes can be applied in two ways:
  - Fully adhered with solvent based adhesives
  - Loose laid and ballasted with stone or other (Con't)

# Ethylene-Propylene-Diene-Monomer (EPDM) Membrane



| ADVANTAGES OF EPDM | DISADVANTAGES OF EPDM |
|---|---|
| Excellent water resistance | Poor oil and gas resistance |
| Excellent weather resistance | Poor puncture resistance |
| Excellent heat resistance | Uses flammable adhesives for bonding |
| Good acid and base resistance | Cannot be easily reinforced |
| Excellent flexibility | Available in limited colours |

# Polyvinyl Chloride (PVC) Membrane



- PVC membranes are single-ply membranes manufactured from a thermoplastic and a glass or polyester reinforcement

- PVC membranes can be applied in the following ways:
  - Adhered
  - Mechanically fastened
  - Loosely laid and ballasted (Con't)

# Polyvinyl Chloride (PVC) Membrane



| ADVANTAGES OF PVC | DISADVANTAGES OF PVC |
|---|---|
| Resistant to acids and bases | Easy to puncture |
| Resistant to bacteria growth | Slippery when wet |
| Excellent fire resistance | — |
| High vapour permeability | — |

# Thermoplastic Polyolefin (TPO) Membrane



- TPO membranes are single-ply membranes manufactured from a thermoplastic and a polyester reinforcement

- TPO membranes can be applied in the following ways
  - Adhered
  - Mechanically attached
  - Loosely laid and ballasted (Con't)

# Thermoplastic Polyolefin (TPO) Membrane

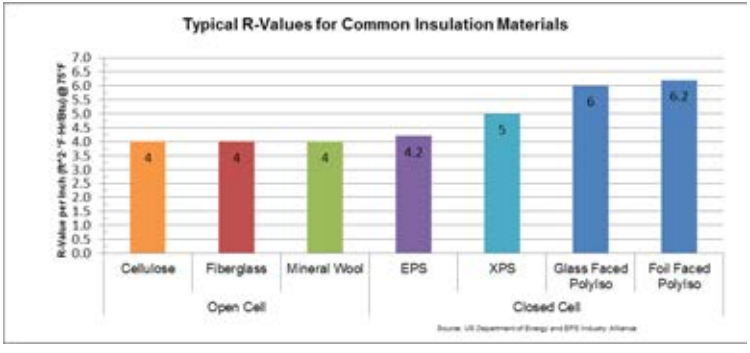


| ADVANTAGES OF TPO | DISADVANTAGES OF TPO |
| --- | --- |
| Low cost | Easy to puncture |
| Resistant to acids and bases | Slippery when wet |

# Types of Thermal Insulation

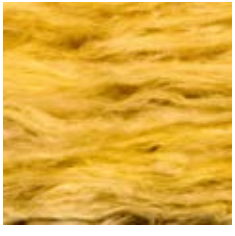


- Common types of insulation are:
  - Open cell
  - Closed cell
- All types of insulation must be mechanically stable to prevent curling and shrinking and must be strong enough to support the traffic loads on the roof



# Open Cell Thermal Insulation

- Common open cell insulation products include:
  - Fiberglass
  - Wood fiber
  - Mineral wool
- Open cell insulations typically have a lower insulating value per inch thickness than closed cell insulations – increasing the required thickness of the roof system
- Open cell insulations are typically more vapour open than closed cell insulations allowing vapour and air to more readily move through the system



# Closed Cell Thermal Insulation

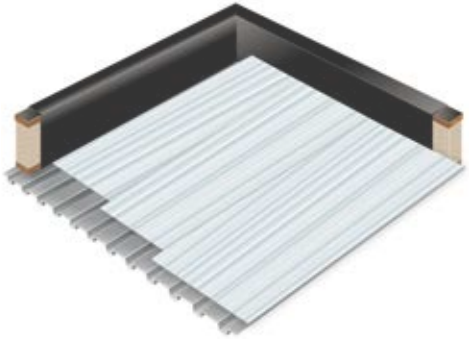


- Closed Cell insulation can be classified in two ways:
  - Thermosetting: insulation will not melt when heated
  - Thermoplastic: insulation will melt when heated
- Polyisocyanurate insulation is the most common thermosetting insulation product
- Extruded and expanded polystyrene are common examples of thermoplastic insulations
- Closed cell insulations typically have a higher insulating value per inch thickness resulting in a reduced roof system thickness

# Types of Vapour Retarder



- Common vapour retarder types are:
  - Bituminous: typically constructed in a two-ply application using hot asphalt over concrete decks or mechanical fasteners through the first ply on wood decks
  - Laminated kraft paper: typically applied to steel decks with the side and end laps sealed with an adhesive
  - Vinyl film: used as an alternative to kraft paper
  - Polyethylene sheet: used as alternative to kraft paper (Con't)



# Types of Vapour Retarder

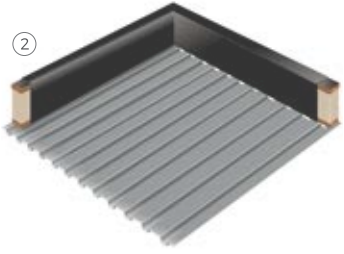


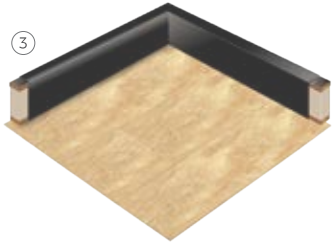
| VAPOUR RETARDER TYPE | ADVANTAGES | DISADVANTAGES |
|---|---|---|
| Bituminous | Robust | Expensive and complicated to install |
| Laminated Kraft Paper<br>Vinyl Film<br>Polyethylene Sheet | Easy to apply | Delicate to install |

# Types of Structural Decks



- There are three primary types of structural decks:
  1. Concrete: most robust and resistant to water in the event of a membrane leak
  2. Corrugated steel: very common due to ease of installation and economy of product
  3. Wood: commonly used in low-rise buildings and is very susceptible to moisture in the event of a membrane failure

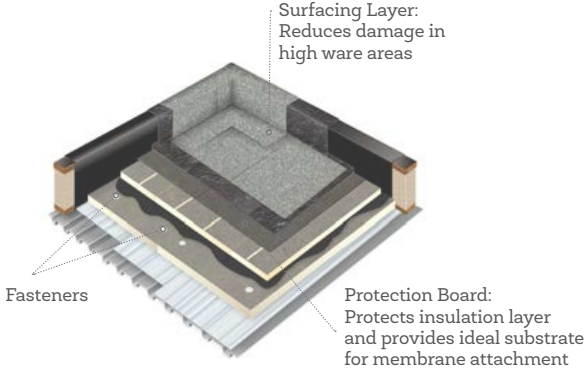



# Secondary Components of an Insulated Roof System



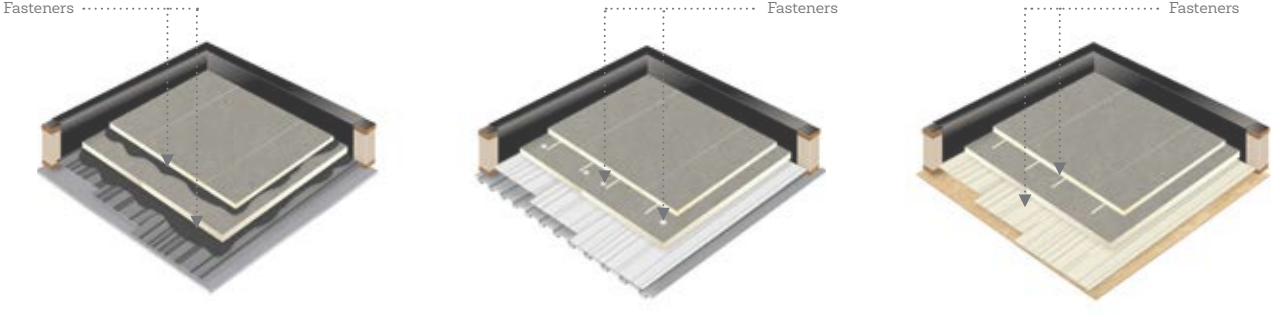
- Secondary components often included to increase the robustness of the system are:
  - Protection board — rigid surface used to protect insulation layer and provide ideal substrate for membrane attachment
  - Surfacing layer — used to reduce damage in high wear areas or increase the performance of the roof system
  - Fasteners — used to join roof system layers together (Con't)




# Secondary Components of an Insulated Roof System



- Fasteners: two basic types of fasteners
  - Mechanical attachment fastens system with the use of screws and plates
  - Adhesive attachment fastens system without the use of screws and plates



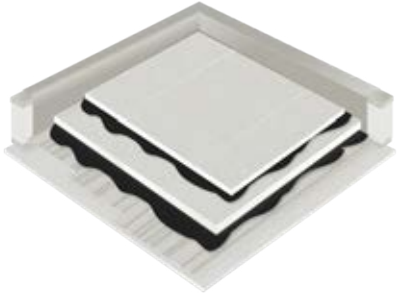

① Hot Asphalt

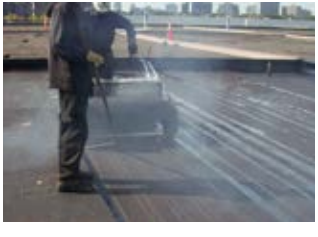
② Mechanical & Cold Adhesive

③ Cold Adhesive

## Fasteners

- Hot Asphalt Adhesive
  - Requires asphalt to be heated to high temperatures and mopped down (Con't)





# Fasteners

- Foamable Low Rise Foam Based Adhesives
  - Used for bonding insulation layers together and to decks
  - Applied at wide range of temperatures

(Con't)

# Fasteners

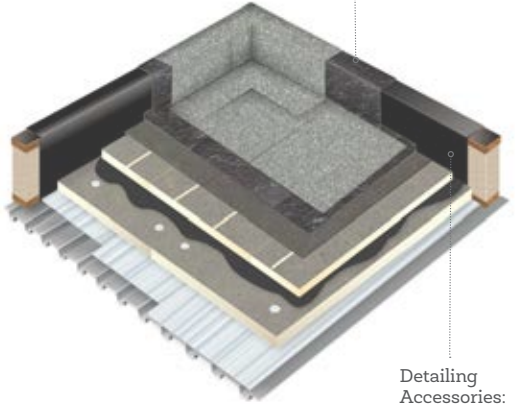


- Mechanical Fasteners
  - Mechanical fasteners and plates pass though insulation attaching to roof deck
  - Thermal bridging can occur through fasteners

# Complementary Components of an Insulated Roof System



- Complementary insulated roof system components include:
  - Primers
  - Flashing strips
  - Detailing accessories



## Specialty Roofs

- Green or vegetative roof:
  - Root barrier, soil and vegetation system are present on roof overtop of waterproofing membrane.
  - Improved water management of roof system, lowered heat island effect and energy loss through roofs seen in these systems.

- Reflective roofing:
  - Reflective surfacing applied to waterproofing membrane.
  - Lowered heat island effect of roof and reduce energy loss through roofs seen in these systems

## Manufacturers

- Many manufacturers of roof membranes also manufacture the complementary insulated roof components, excluding the structural deck, to ensure that all components are compatible and covered under a single warranty.

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