Thermal and Moisture Protection

Moisture Protection

Most building materials are subject to some degradation by exposure to moisture. Building systems must be designed to resist the transfer of moisture to the inside of the structure.

Moisture comes in several forms.

Liquid

The most common way for moisture to enter a building is in its liquid form. Leaks may occur that allow rain or groundwater to infiltrate the building envelope.

This leak may not be immediately apparent, leading to a variety of maintenance and health concerns.

Liquid

Another source of liquid is condensation. When the vapor in air reaches a critical temperature, referred to as the dew point, condensation occurs.

This condensate must be addressed to prevent damage to the structure and discomfort the occupants.

Vapor

Moisture may also enter a structure in the form of vapor. This vapor may migrate through building materials that are not adequately protected.

Small openings in the building will also allow the transfer of vapor.

Vapor

Vapor can migrate through construction materials, entering into construction assemblies, like walls and roofs.

Vapor will typically move from the warm side of the assembly toward the cool side of the assembly. (This is related to the thermal conduction process.)

Vapor

As vapor migrates into cooler materials, it will reach an important temperature referred to as the condensation point or dew point.

This is the temperature at which vapor molecules condense to form moisture. This moisture will be in contact with the various materials within the assembly.

Vapor

Vapor also enters enclosed attic spaces. It is important to provide paths for moist air to leave attics, allowing drier fresh air to be drawn in at the same time.

Building code provides specific ventilation requirements for these spaces.

Vapor

Attic ventilation should be placed at high and low locations of the attic, allowing for exhaust of warm air at high locations and intake of cooler air at low locations.

EnergyStar provides complete attic venting information, as well as a downloadable guide with graphics, instructions, glossary and more.

Ice

While it is not common for ice to enter a building, the build-up of ice often leads to water infiltration, as evident in “ice dam” conditions on sloped roofs.

Dampproofing

Dampproofing is the application of a material to <u>reduce</u> the likelihood of moisture transfer to the inside of a structure.

Dampproofing assumes no hydrostatic pressure is “pushing” the moisture toward the building.

Waterproofing

Waterproofing is the application of a material to prevent the transfer of moisture in liquid form to the inside of a structure in the presence of hydrostatic pressure.

Application

Dampproofing and waterproofing may appear to be identical applications, often a spray-on asphaltic compound designed to resist moisture. It is often applied directly to the foundation or sub-grade structure.

Thermal Protection

Critical for building to provide comfortable spaces for occupants.

Owners and designers must also consider the overall impact of their designs on the environment and how a building consumes energy.

Building use approximately 40% of the energy consumed in the United States.

Thermal Protection

Maintain comfort for building occupants while minimizing the energy requirements of the structure.

Heating

Cooling

Thermal Protection

Insulate exterior walls, roof and floors located over outdoor space.

Minimize potential heat gain or loss by building with materials that resist heat transfer (high R-value).

R Value

Measure of a material's resistance to heat flow in units of Fahrenheit degrees x hours x square feet per Btu.

The higher the R-value of a material, the greater its insulating capability. The R-value of some insulating materials is 3.7 per inch for fiberglass and cellulose,2.5 per inch for vermiculite, and more than 4 per inch for foam. All building materials have some R-value.

U. S. Department of Energy

Thermal Protection

The physics of heat transfer is beyond the scope of this course, but more information is available at:

Spirax Sarco (commercial website)

A Heat Transfer Textbook

(Free download for engineering students. Provided by MIT.)

Thermal Protection

Most common means of achieving thermal protection is the installation of insulation.

Common insulation types:

- Batt (fiberglass)
- Loose (cellulose)
- Foam (polystyrene or polyisocyanurate)

Thermal Protection

Building code will help determine a minimum requirement for insulation performance. Work with the building designer, contractor and owner to determine the optimal building performance.

Many types of insulation will require a protective cover, and may not be exposed as the building is occupied.

Thermal Protection

Batt insulation is typically placed within wall, attic or floor cavities to provide thermal isolation. Often made of fiberglass.

Thermal Protection

Blown-in loose insulation, available in bulk, may be installed on level or slightly sloped areas. Often made of cellulose.

Thermal Protection

Loose insulation may also be installed in wall cavities if a support method is appropriately designed (netting to support material, or glue to adhere to other building materials.)

Thermal Protection

Foam insulation may be sprayed in place. It will expand to fill cavities. Consider the effects of its expansion and its impact on the overall structure.

Thermal Protection

Rigid foam insulation is available in board or sheet sizes. It may be cut and fixed in place with adhesive or fasteners.

Analysis Software

The U. S. Department of Energy provides free downloads of energy analysis software. Most building authorities will accept either the commercial or residential versions of this analysis.

Additional software is available from various vendors, usually for a fee.

COMCheck

The COM*check* materials have been developed to simplify and clarify commercial code compliance with the International Energy Conservation Code (IECC), ANSI/ASHRAE/IESNA Standard 90.1, and state-specific codes.

REScheck

The *REScheck* materials have been developed to simplify and clarify residential code compliance with the Model Energy Code (MEC), the International Energy Conservation Code (IECC), and state-specific codes.

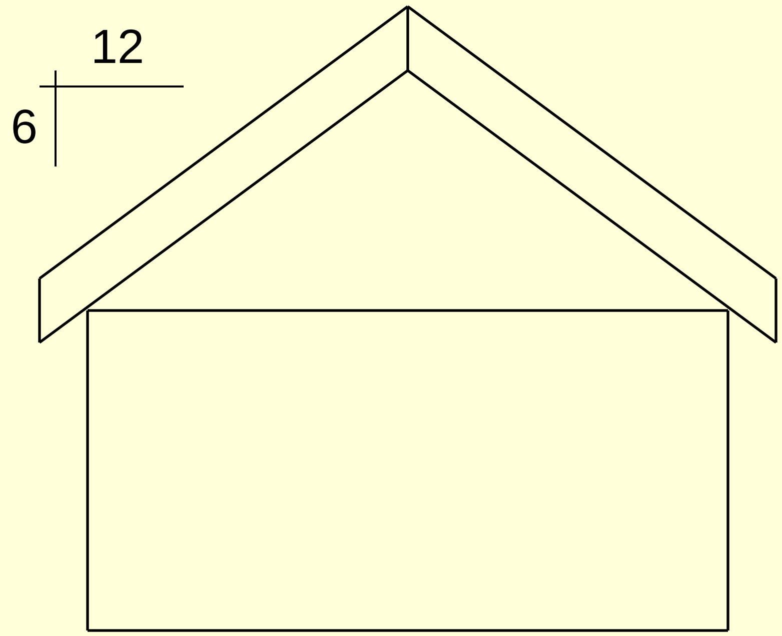
Steep Slope Roofing

Roof slope is often expressed as a ratio of rise to run, or distance travelled vertically to distance travelled horizontally.

The unit of measure is not relevant, as long as it is consistent.

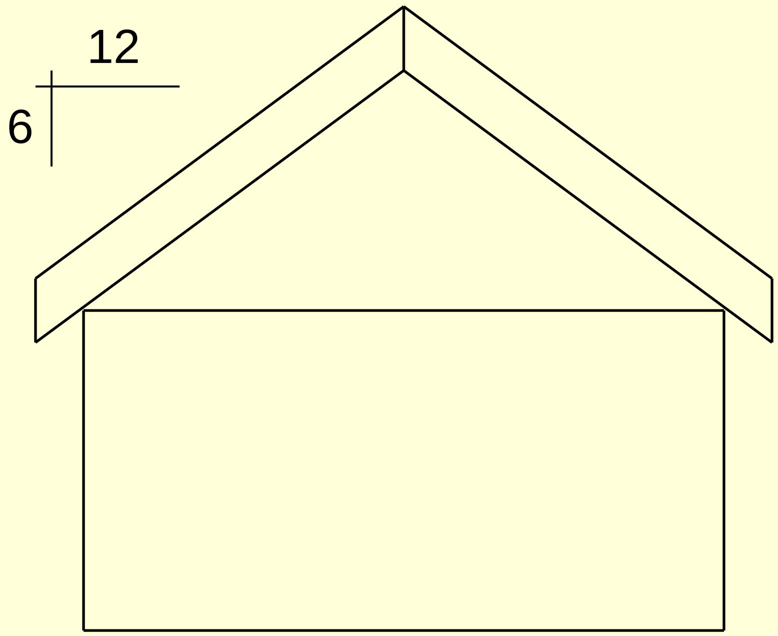
Steep Slope Roofing

For instance, the roof depicted below as a ratio of rise to run of 6 units to 12 units.



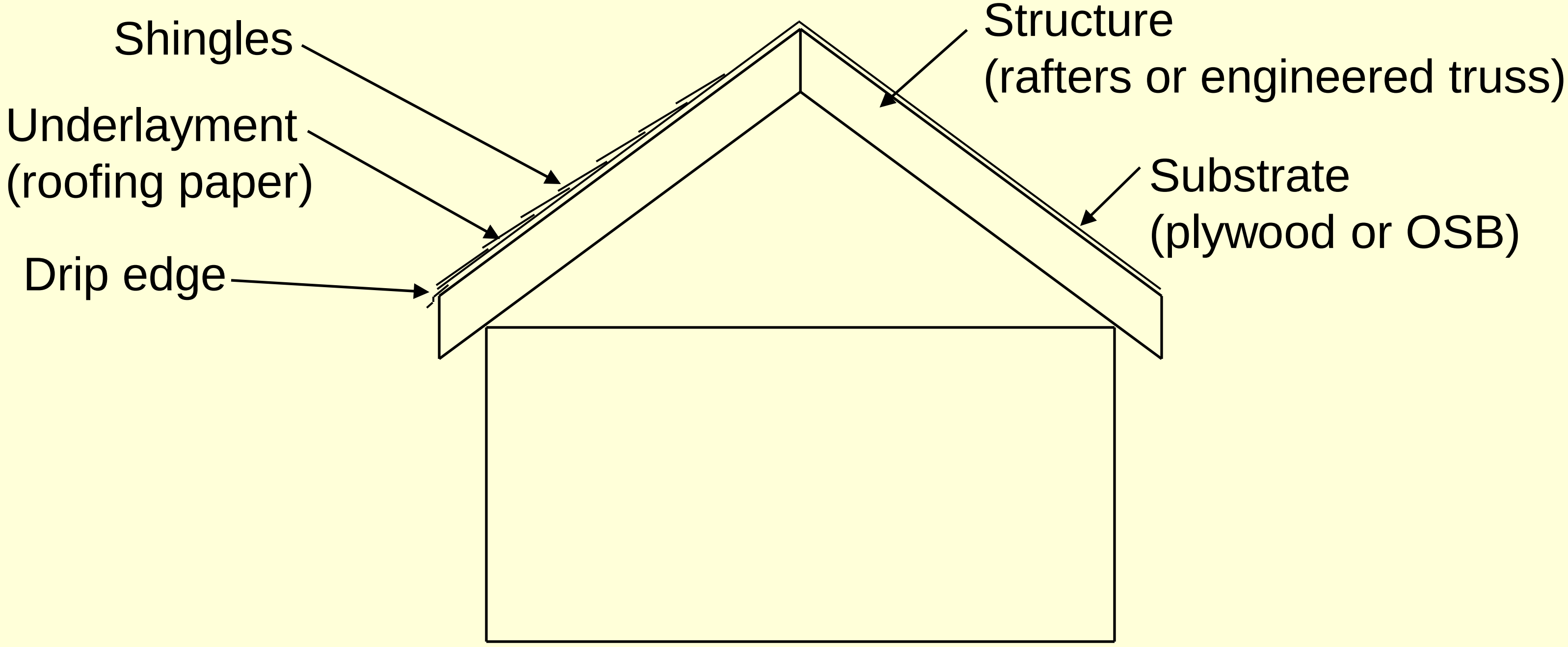
Steep Slope Roofing

Roofing materials must be selected with the roof slope in mind. Roofs with a slope greater then 3 units in 12 units are usually considered steep.



Steep Slope Roofing

Roofing is actually a system built of multiple components, including:



Steep Slope Roofing

Common steep slope roofing materials include shingles of several materials.

- Asphalt and Fiberglass shingles
- Wood shingles or shakes
- Cement shingles
- Metal shingles

Most are applied using a typical installation method of nailing the shingles to a substrate in an overlapping manner.

Steep Slope Roofing

The structure of a roof is determined by the design, but for steep slope roofing typically includes rafters (individual framing members) or engineered trusses (assemblies constructed offsite and placed as a group).

Membrane Roofing

Flat roofs (less than a 3:12 slope), often receive a membrane roofing system.

Flat roofs include built-up and single-ply versions.

Membrane Roofing

Flat roofs (less than a 3:12 slope), often receive a membrane roofing system.

Membrane roofs have two typical configurations:

- Single ply
- Built-up (multiple ply)

Membrane Roofing

Single ply roofing options:

Thermosets

Thermoplastics

Modified Bitumens

Membrane Roofing

Thermosets

Thermoset membranes are compounded from rubber polymers. The most commonly used polymer is EPDM (often referred to as "rubber roofing"). Another thermoset material is neoprene, although this particular formulation is no longer widely used for roofing. Thermoset membranes are successful for use as roofing materials because of their proven ability to withstand the potentially damaging effects of sunlight and most common chemicals generally found on roofs.

Membrane Roofing

Thermoplastic

Thermoplastic membranes are based on plastic polymers. The most common thermoplastic is PVC (polyvinyl chloride) which has been made flexible through the inclusion of certain ingredients called plasticizers. A number of different products in this category are available, each having its own unique formula.

Membrane Roofing

Thermoplastic

Thermoplastic membranes are identified by seams that are formed using either heat or chemical welding. These seams are as strong or stronger than the membrane itself. Most thermoplastic membranes are manufactured to include a reinforcement layer, usually polyester or fiberglass, which provides increased strength and dimensional stability.

[Single Ply Roofing Industry]

Membrane Roofing

Modified Bitumen

Modified bitumen membranes are interesting hybrids that incorporate the high tech formulation and prefabrication advantages of single-ply with some of the traditional installation techniques used in built-up roofing. These materials are factory-fabricated layers of asphalt, "modified" using a rubber or plastic ingredient for increased flexibility, and combined with a reinforcement for added strength and stability.

Membrane Roofing

Modified Bitumen

There are two primary modifiers used today: APP (atactic polypropylene) and SBS (styrene butadiene styrene). The type of modifier used may determine the method of sheet installation. Some are mopped down using hot asphalt and some use torches to melt the asphalt so that it flows onto the substrate. The seams are sealed by the same technique.

Built-up Roofing

Built up roof membranes, referred to by the acronym BUR, have been in use in the U.S. for more than 100 years. These roof systems are commonly referred to as "tar and gravel" roofs. BUR systems generally are composed of alternating layers of bitumen and reinforcing fabrics that create a finished membrane.

Built-up Roofing

The number of plies in a cross section is the number of plies on a roof: The term "four plies" denotes a four ply roof membrane construction. Sometimes, a base sheet, used as the bottommost ply, is mechanically fastened. Built up roofs generally are considered to be fully adhered if applied directly to roof decks or insulation.

Flashing and Sheet Metal

Buildings include the intersection of many different types of materials. Special attention needs to be paid to these intersections.

Materials expand and contract as their temperature changes, as well as when they absorb or shed moisture. Buildings also move due to settlement, seismic activity, wind loads, live loads or other loads.

Flashing and Sheet Metal

Joints between materials must be designed, installed and maintained to assure proper performance. In many instances, metal flashings or joints will be needed to make these various transitions.

Roof and Wall Specialties

Many of the terminations of roofing and walls require specialized materials to make a weather resistant condition. These products or assemblies are classified as Roof and Wall Specialties.

Environment

Thermal and Moisture Protection are vital aspects in designing, constructing and maintaining an environmentally responsible structure. Careful consideration should be given to each component of these systems.

Environment

Leadership in Environmental and Energy Design (LEED), a program spearheaded by the U. S. Green Building Council, provides guidance for many areas of building, including thermal and moisture performance.

LEED offers degrees of certification of structures, and provides validation of the quality and predicted performance of many structures.

Environment

LEED is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across all the metrics that matter most: energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts.

U.S. Green Building Council