# MOISTURE PROTECTION AND THERMAL INSULATION

A preparatory course assembled for the
Architectural Record Examinations

Data accumulated from Kent Ballast's "Architecture Exam Review," and various sources of the Internet

*(This is only for educational purposes)*

AVANT-GARDE ENGINEERING LLC
CONSULTING ARCHITECTS/ENGINEERS

# INTRODUCTION

- Protecting buildings from water leakage and temperature transmission are two of the most troublesome technical problems.
- Water can leak into a building from underground moisture and groundwater and from precipitation on the roof and exterior walls. It can find its way into a building through a surface material such as roofing or a basement slab or through joints and penetrations between materials.
- Moisture can also be generated within a building from cooking, showering, or simple human habitation. This moisture must also be prevented from permeating the structure.
- We will discusses the methods and materials used to protect a building from moisture and to control heat loss or heat gain.

Image sources: http://www.inspectapedia.com, http://www.relaxedhomeschool.com, April 2008

# DAMPPROOFING

- Dampproofing is the control of moisture that is not under hydrostatic pressure. This includes water-repellent coatings on concrete, masonry, and wood walls above grade, but the most typical use of the term is for describing protection of slabs and foundation walls below grade that are subject to continuous exposure to moisture.

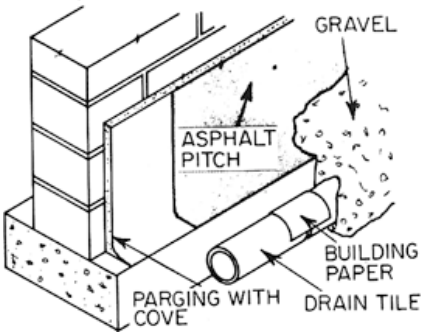



Image source: http://www.answers.com, April 2008



# DAMPPROOFING

- Types of dampproofing:
  - Admixtures: Various types of admixtures can be added to concrete to make it water repellent. These include materials such as salts of fatty acids, mineral oil, and powdered iron. They may reduce the strength of the concrete, but they make it much less permeable to water.
  - Bituminous coatings: These are asphalt or coal tar pitch materials applied to the exterior side of the foundation wall. They may be brushed or sprayed on, can be applied either hot or cold (depending on the type), and should be applied to smooth surfaces. They do not, however, seal cracks that develop after they are applied.

# DAMPPROOFING

- Types of dampproofing cont.
  - Cementitious coatings: One or two coats of portland cement mortar can be troweled over the surface of masonry or concrete foundation walls. Mortar coatings are often used over very rough walls to provide a smooth surface for other dampproofing materials or by themselves. Powdered iron is often added as an admixture to the mortar. As the iron oxidizes it expands and limits the amount of shrinkage of the material, making a tighter seal.



# DAMPPROOFING

- Types of dampproofing cont.
  - Membranes. These methods include built-up layers of hot or cold applied asphalt felts or membranes of butyl, polyvinyl chloride, and other synthetic materials. However, membranes are usually used for waterproofing walls subject to hydrostatic pressure, and their cost and difficulty of application is usually not warranted for simple dampproofing.
  - Plastics. Silicone and polyurethane coatings are available, but they are usually reserved for above-grade dampproofing.

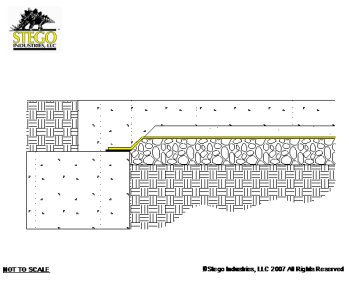
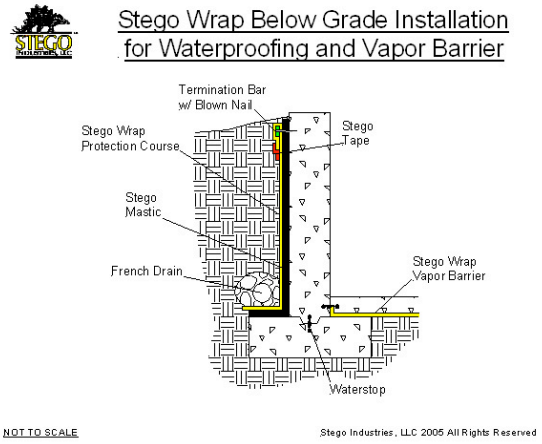



Image source: Stego Industries

# WATERPROOFING

- Waterproofing is the control of moisture and water that is subject to hydrostatic pressure. This may include protecting structures below the water table.
- Waterproofing is a more difficult technical problem than is dampproofing because of the water pressure and the need to create a continuous seal over walls, slabs, and joints in the structure.






# WATERPROOFING

- In most cases, waterproofing membranes are used on the exterior of the walls and slabs. These may be built-up layers of bituminous saturated felts similar to roofing, or single-ply membranes of synthetic materials such as butyl, polyvinyl chloride, or other proprietary products.
- When membranes are used, they are subject to puncture during backfilling operations. For this reason, a protection surface is placed over the waterproofing prior to backfilling.

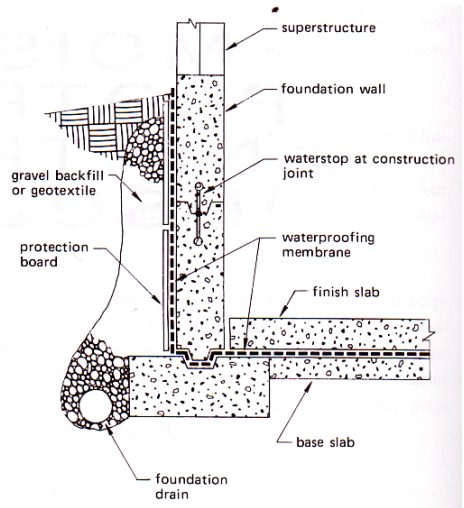
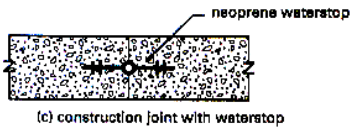



Image source: Ballast, K.: Architecture Exam Review, Vol. II Nonstructural Topics, pp: 20:2, 4th Edition, Belmont CA 1998

# WATERPROOFING

- Joints in waterproofed walls are particularly subject to leakage.
- In concrete walls, waterstops are used to seal construction joints. Waterstops are dumbbell-shaped, continuous rubber or neoprene extrusions.
- Half of the waterstop is placed in the form during the first pour of concrete, and the other half is allowed to extend into the second pour.



(c) construction joint with waterstop

Picture source: Ballast, D.K.: *Architectural Exam Review, Vol II*, pg.15-9, Professional Publications, Belmont, CA, 1998.



# WATERPROOFING

- Another method of waterproofing is the use of bentonite panels. These are flat packages of bentonite clay inside kraft paper packages. They are placed under slabs and against walls. After backfilling, the kraft paper deteriorates and the clay expands in the presence of moisture to form a waterproof barrier.

Image source: http://www.spec-net.com.au/company/neoferma.htm, April 2008

# WATERPROOFING

- Naturally, even when dampproofing or waterproofing a wall below grade, good construction design should include creating a positive slope away from the building to minimize water penetration around the foundation and provide some type of perimeter drainage if a heavy concentration of water is anticipated.
- This may include backfilling with gravel and placing perimeter foundation drains at the footing line.
- Hydrostatic pressure buildup can also be alleviated by using a geotextile matting over the waterproofing.

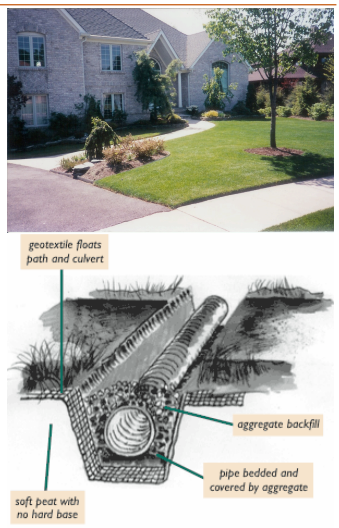
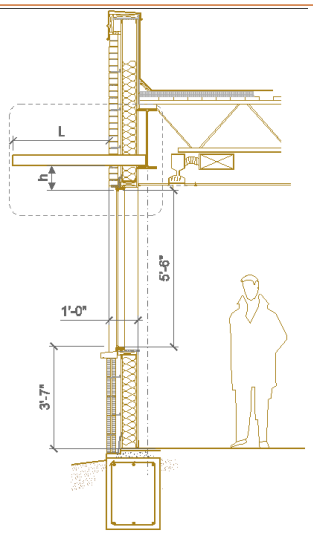



Image source: http://www.scapesdesign.net,April 2008
Image source: http://www.smh.org.uk, April 2008



# BUILDING INSULATION

- Insulation is used to control unwanted heat flow, which can be from a warm building to a cold exterior or from a hot climate into a habitable space.
- Selecting and detailing insulation for buildings requires an understanding of the processes of heat gain and heat loss because different kinds of insulation are used to control them.



# BUILDING INSULATION

- Methods of Heat Transfer:
- Heat is transferred in three ways: conduction, convection, and radiation.
  - Conduction is the flow of heat within a material or between materials without displacement of the particles of the material.
  - Convection is the transfer of heat within a fluid, either gas or liquid, by the movement of the fluid from an area of higher temperature to an area of lower temperature.
  - Radiation is the transfer of heat energy through electromagnetic waves from one surface to a colder surface.

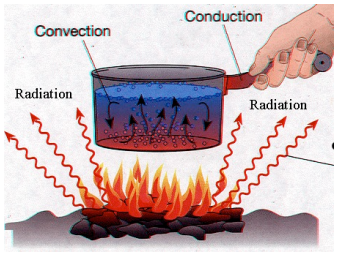
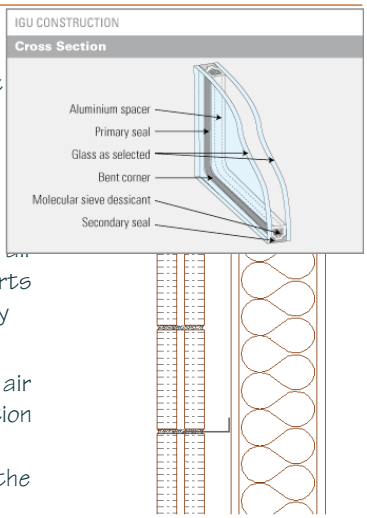



Image source: http://www.appliance.net, April 2008



# BUILDING INSULATION

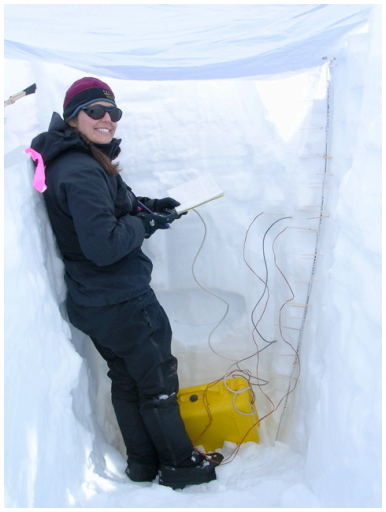
- Methods of Heat Transfer cont.:
  - The best insulation is a vacuum. The next best insulation is air kept absolutely motionless in a space between two materials.
  - However, this does not usually occur because convection currents carry warm air in one part of the space to the cooler parts of the space where heat is transferred by conduction.
  - Most insulations are designed to create air pockets small enough to prevent convection but large enough to prevent the direct transfer of heat by conduction between the insulating material.




Vacuum sealed double pane window: Image Source: http://www.metroglasstech.co.nz, April 2008

# BUILDING INSULATION

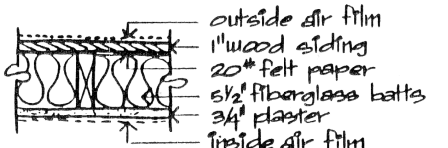
- **Measuring Thermal Resistance:**
- Thermal resistance is described with several terms. The quantity of heat used to measure transfer is the British thermal unit (BTU), which is the amount of heat required to raise the temperature of 1 pound of water by 1°F.
- The basic unit of conductance is a material's k value, or *conductivity*. This is the number of BTUs per hour that pass through 1 square foot of homogeneous material 1 inch thick when the temperature differential is 1°F.
- When the material is more than 1 inch thick, the unit is *conductance*, or the C value.





# BUILDING INSULATION

- **Measuring Thermal Resistance cont:**
- The more common term used is the R value, or resistance of a material. Resistance is the number of hours needed for 1 BTU to pass through 1 square foot of a material of a given thickness when the temperature differential is 1°F It is the reciprocal of conductance.
- Thus, the lower a material's k or C value, the better its insulating qualities. Higher R values also indicate a better insulating value.
- There are three types of insulation that can control heat transfer: Loose, batt, and rigid.




| Material | Thickness | r | R | U |
|---|---|---|---|---|
| outside air | — | — | .17 (.62) | |
| wood siding | 1.0 in. | 1.25 | 1.25 | |
| felt paper | — | — | 0.06 | |
| fiber glass | 5.5 in. | 3.17 | 17.40 | |
| plaster | .75 in. | 0.18 | .14 | |
| inside air | — | — | .62 (.17) | |
| TOTAL (Ur = 1/Rt) | | | 19.7 | 0.05 |

# BUILDING INSULATION

- **Loose Insulation:**
- Loose or fill insulation, as it is sometimes called, is made from several materials.
  - Rock wool is a fibrous material formed by blowing molten rock under pressure;
  - perlite is volcanic rock expanded by heating;
  - and vermiculite is mica expanded by heating.
- Rock wool, perlite, and vermiculite are all noncombustible and have good thermal resistance.

Perlite Insulation, Image source: http://www.midwestearthbuilders.com, April 2008



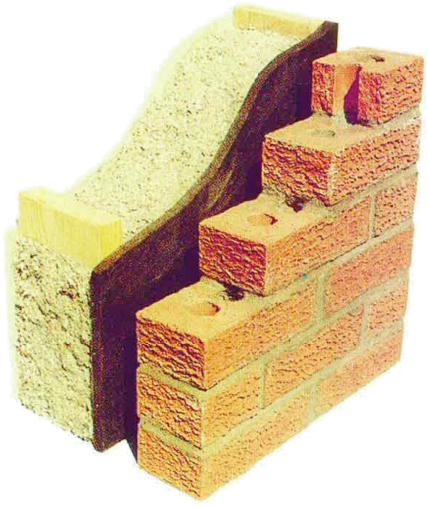
# BUILDING INSULATION

- **Loose Insulation cont.:**
- Cellulose is shredded wastepaper or wood fibers. By itself, cellulose is combustible, but chemicals are added to make it fire resistant and to inhibit the growth of fungus and repel rodents.
- Granular pellets of foamed plastic, such as polystyrene, are also available as fill insulation.

Image source: http://www.advancedinsulationinc.net, April 2008

# BUILDING INSULATION

- **Loose Insulation cont:**
- Loose insulation is used for pouring into cavities such as cells of concrete block walls and other hard-to-reach places. It is also widely used in retrofit applications because it can be blown into wall and ceiling cavities where other types of insulation cannot be installed or will take great difficulty.





# BUILDING INSULATION

- **Batt Insulation:**
- Batt insulation consists of fibrous material placed on or within a kraft paper carrier. The insulation is usually mineral fiber or glass fiber.
- In addition to providing a means of installation and holding the insulation in place, the kraft paper also serves as a vapor barrier. Some batt insulation also comes with a reflective surface.
- Batts come in standard widths designed to fit within stud and joist spacings of 16" or 24" on center. It is either friction fitted or is attached by stapling the paper flanges to the studs. Various thicknesses are available to suit the size of the cavity and the R value required.


Image source: http://www. rd.com, April 2008

# BUILDING INSULATION

- **Batt Insulation cont.:**
- If an integral vapor barrier is included, it should be placed on the warm side of the insulation (that side facing the heated room) to prevent condensation of moisture vapor from the interior from forming on the insulation, thus decreasing its effectiveness.

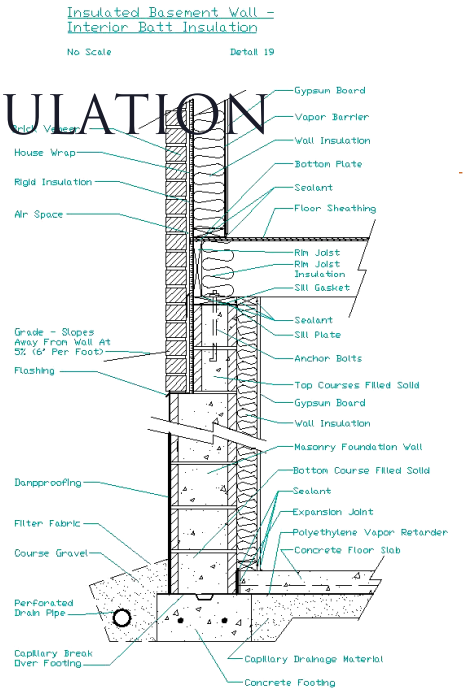



Image source: http://www.neo.ne.gov, April 2008

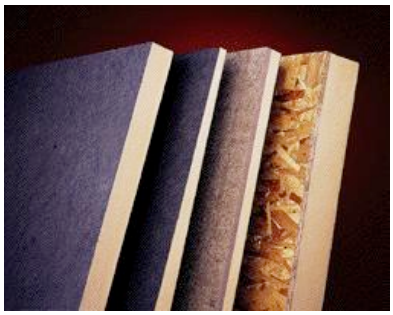


# BUILDING INSULATION

- **Rigid Insulation:**
- Rigid insulation comprises two types: boards and sprayed- on. Organic board insulation is made from wood or cane fiber sandwiched between coatings of bituminous material, paper, foil, or other materials.
- Rigid boards can also be made with perlite or cork. However, organic board insulation has generally given way to the inorganic plastics, which have much higher insulating values.

# BUILDING INSULATION

- **Rigid Insulation cont.:**
- Inorganic foamed insulation is made from polyurethane (PUR), polystyrene, or polyisocyanurate (PIR). If the insulation is formed with closed cells, it has a much higher resistance to moisture. These are the types appropriate for foundation insulation and other situations where water may be present.
- Fiberglass and perlite rigid board are also available for use as wall or roof insulation. Rigid insulation may be purchased with foil coverings to act as vapor barriers and as reflective insulation.



Series of Polyisocyanurate Insulations: standard flat, tapered, perlite composite, amd oriented strand board. Image source: http://advancedproductsroofing.com/fi...one.html, April 2008



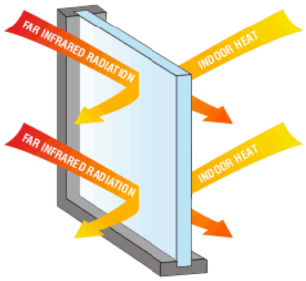
# BUILDING INSULATION

- **Reflective Insulation:**
- Reflective surfaces have two properties that make them good for insulation.
  - The first is reflectivity, which simply means that the surface reflects radiant heat and strikes it back to the source.
  - The other property is emissivity.

Image source: http://www.prweb.com, April 2008

# BUILDING INSULATION

- **Reflective Insulation cont.:**
- Emissivity is a measure of the ability of a material to radiate, heat. A foil-faced insulation will emit very little heat that it happens to receive by conduction. Similar is the absorbtivity measure by inversing the process.
- To be most effective, reflective insulation should be used in conjunction with a closed air space on at least one side of the material.




The case of Low Emissivity windows as presented in earlier sessions. Image source: http://www.apexfilms.ca, April 2008



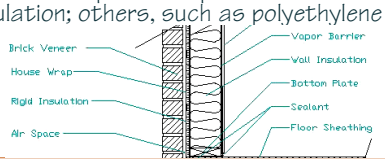
# BUILDING INSULATION

- **Vapor Barriers:**
- A vapor barrier is a material used to prevent the transmission of water vapor between spaces. Vapor barriers are not themselves insulation, but they play an important role in the effectiveness of other insulating materials.
- Water vapor is produced in all buildings by human respiration and perspiration, by cooking, and by other activities that involve water.


Image source: http://houstonrealestate.typead.com, April 2008

# BUILDING INSULATION

- **Vapor Barriers cont.:**
- In addition, there is always a certain amount of humidity present in the air. Warm air is capable of holding more water than is cold air. If the temperature of the air containing a certain amount of water vapor drops, the relative humidity rises until the saturation point is reached. This is known as the dew point, the point at which water condenses from the vapor.
- During a cold day, water vapor in the air can pass through many building materials into the wall and ceiling cavities. If the temperature is cold enough the water condenses, wetting the insulation and greatly reducing its effectiveness. In addition, the water can soak wood and other materials, promoting their deterioration.
- To avoid this, vapor barriers are placed on the warm side of the insulation to prevent the water from reaching the dew- point temperature. Some vapor barriers are integral with the insulation; others, such as polyethylene films, are applied as separate sheets.






# SHINGLES AND ROOFING TILE

- Shingles and tiles are amongst the oldest roofing materials and they are both arranged by a method of overlapping on a sloping surface, shedding water, leaves, snow, debris, and other airborne material that reaches our roofs.

A very interesting arrangement of ceramic tiles set on a vertical wall: Image source:http:/miniatures.about..com, May 2008

# SHINGLES AND ROOFING TILE

- Types of Roofs:
- Roofs are classified according to their shape. Some of the more common types are illustrated along with the common terms used to describe the various parts.
- The amount of slope of a roof is designated by its pitch, which is the number of inches of rise for every 12" of horizontal projection or run. For example, a 5/12 pitch rises 5" vertically for every foot of horizontal projection.

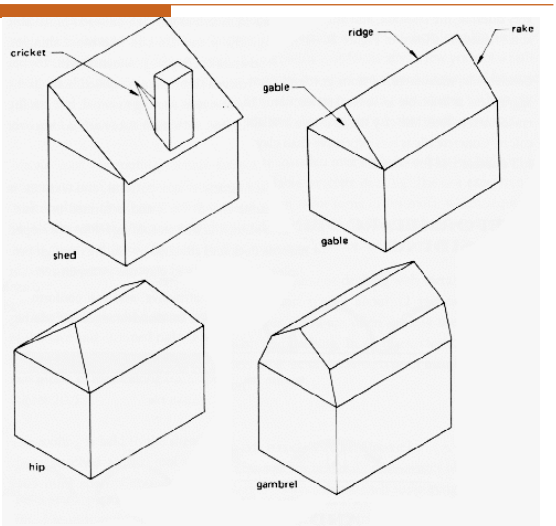



Image source: Ballast, K.: Architecture Exam Review, Vol. II Nonstructural Topics, pp: 20:5, 4th Edition, Belmont CA 1998



# SHINGLES AND ROOFING TILE

- Types of Roofs:
- Not all roofing materials are appropriate for all pitches, although the exact pitch for any one material may affect how the roofing is detailed and installed. For example, low-slope roofs for asphalt shingles require a double layer of roofing felt rather than the normal single layer.
- When describing size, estimating, and ordering materials, roofing area is referred to in squares. A square is equal to 100 square feet.

| | Slope—Vertical Rise | | | |
|---|---|---|---|---|
| | in inches per 12 in | | in millimeters per 305 mm | |
| Roofing Type | min. | max. | min. | max. |
| asphalt shingles, low slope | 2 | 4 | 50 | 100 |
| asphalt shingles, normal | 4 | 12 | 100 | 305 |
| asphalt roll roofing | 1 | 4 | 25 | 100 |
| wood shingles | 4 | – | 100 | – |
| clay tile | 4 | – | 100 | – |
| slate tile | 4 | – | 100 | – |
| metal roofing | 3 | – | 75 | – |
| built-up roofing | 1/4 | 1 | 6 | 25 |
| single-ply membranes (varies with type and method of attachment) | 1/4 | 6 | 6 | 150 |

Source: Ballast, K.: Architecture Exam Review, Vol. II Nonstructural Topics, pp: 20:5, 4th Edition, Belmont CA 1998

# SHINGLES AND ROOFING TILE

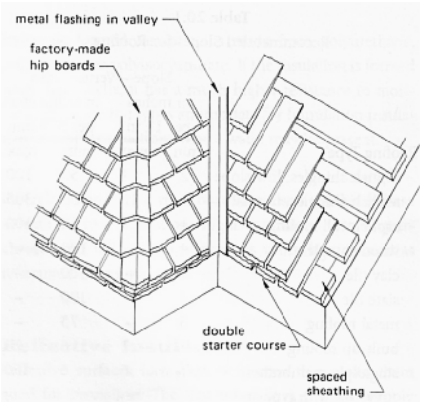
- Shingles
- Shingles are small, rectangular, or other-shaped units intended to shed water rather than form a watertight seal. Asphalt shingles are made from a composition of felt, asphalt, mineral stabilizers, and mineral granules.
- They are available in a variety of colors and shapes and are laid over an asphalt-impregnated roofing felt that is nailed to solid wood sheathing.

Image source:http:/www.thisoldhouse.com, May 2008



# SHINGLES AND ROOFING TILE

- Shingles:
- Wood shakes are normally manufactured from cedar and are available in a variety of grades (no. 1, blue label being the best) and finishes including smooth face and handsplit face.
- Wood shingles are typically laid over spaced sheathing so that they can breathe without a buildup of moisture.



# SHINGLES AND ROOFING TILE

- Shingles cont:
- Wood shingles are laid so that only a certain portion of each shingle is visible. This is called the exposure, and the dimension varies with the pitch of the roof.
- The edges are staggered so that joints do not coincide, and 30-pound asphalt felt is used as an underlayment.

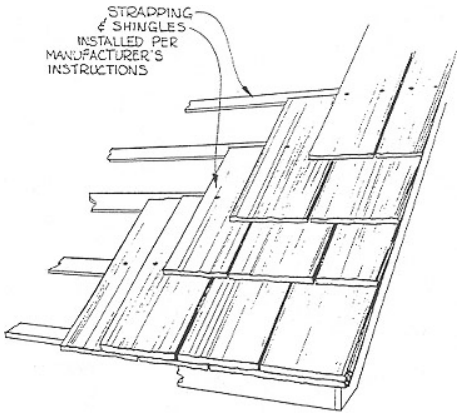



Image source:http:/www.winterpanel.com, May 2008



# SHINGLES AND ROOFING TILE

- Roofing tile:
- Roofing tile consists of slate, clay tile, and concrete tile. Because each type is heavy (10 psf, or more), the roof structure must be sized accordingly
- Slate tile is made by splitting quarried slate into rectangular pieces from 6" to 14" wide and from 16" to 24" long.

Image source:http:/www.krashouse.ca, May 2008

# SHINGLES AND ROOFING TILE

- Roofing tile cont.:
- *Slate* tile is about 1/4" in thickness. It is laid over 30lb asphalt-saturated roofing felt on wood or nailable concrete decking.
- The pieces are laid like other shingles, with the sides and ends overlapping, attached with copper or galvanized nails driven through prepunched holes in the slate.
- Slate is very expensive as roofing material, but it is fire resistant and very durable, with most slate roofs lasting over 100 years.

Image source:http:/www.recyclethis.co.uk, May 2008



# SHINGLES AND ROOFING TILE

- Roofing tile cont.:
- *Clay* tile, available in many colors, patterns, and textures, is made from the same clay as brick and is formed into various shapes.
- Like slate, it is laid on roofing felt over a sloped wood or nailable deck and attached by nailing through prepunched holes. Also like slate, clay tile is expensive, but very durable, fire resistant, and attractive.

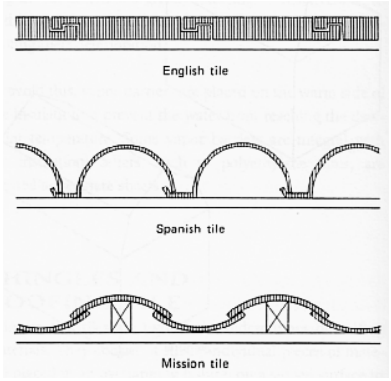



Image source: Ballast, K.: Architecture Exam Review, Vol. II Nonstructural Topics, pp: 20:6, 4th Edition, Belmont CA 1998

# SHINGLES AND ROOFING TILE

- Roofing tile cont.:
- *Concrete* tile, manufactured from portland cement and fine aggregates, is available in several styles, some flat and others formed to look like clay tile. It is also available in several colors.
- Concrete tile is less expensive than clay tile, but it is still durable and fire resistant.

Image source:http:/www.bradlewis.com, May 2008



# PREFORMED ROOFING AND SIDING

- Sheet Metal Roofing:
- Metal roofing is resilient, robust, pleasing, and can be used in formulating a wide variety of shelter shapes. It is however expensive as material and with the difficulty of installing it properly, the option of metal roofing becomes even more dear.
- Metal roofs are usually fabricated of sheets of metal joined in various ways, like soldering, interlocking, brazing etc.
- Because of the high coefficient of expansion of metals used for roofing, these joints and other parts of the roofing system must be designed to allow for expansion and contraction.



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# PREFORMED ROOFING AND SIDING

- Sheet Metal Roofing cont.:
- Metals used for roofing include copper, galvanized iron, aluminum, and terne plate. *Terne* plate is steel sheet coated with lead and tin. Tene-coated stainless steel is also available.
- Other metals that are sometimes used include stainless steel, zinc, and lead. Stainless steel is expensive but very durable and maintenance free.

Image source: http://designawards.files.wordpress.com, April 2008



# PREFORMED ROOFING AND SIDING

- Sheet Metal Roofing cont.:
- Copper roofs appeal to us for their longevity and their attractiveness with the patina that forms after weathering. Pollution and cold humid weather accelerate the oxidization of copper.
- Copper is also a good metal roofing material because a large number of roofing accessories, like gutters, downspouts or gutters can also be fabricated with copper.

The Fairmont Hotel in Vancouver



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# PREFORMED ROOFING AND SIDING

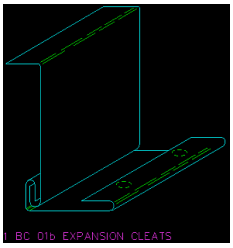
- Sheet Metal Roofing cont.:
- Metal roofs are installed over asphalt roofing felt laid on top of wood or nailable concrete decking. The one exception to the underlayment is for teme or tin roofs, which require a rosin-sized paper because the asphalt can react with the tin. The minimum slope for metal roofs is 3 in 12.

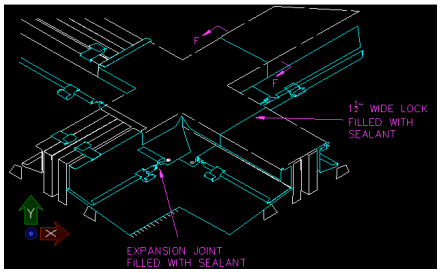
The Fairmont Hotel in Vancouver



# PREFORMED ROOFING AND SIDING

- Sheet Metal Roofing cont.:
- In most cases, standing seams are made parallel to the slope of the roof and crimped tight. Flat seams are made perpendicular to the standing seams and soldered. These connect two pieces of metal along the slope of the roof.



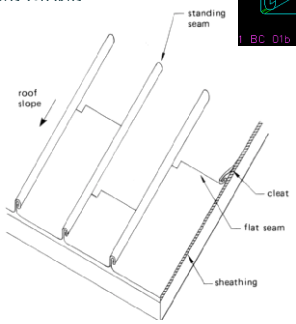
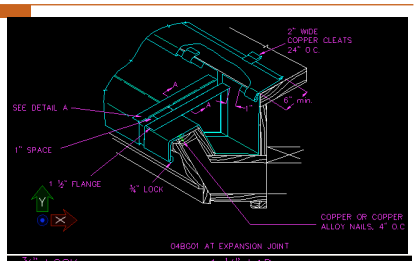
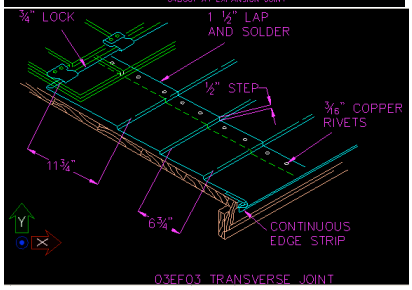




Image source: Revere Copper, Massachussetts

# PREFORMED ROOFING AND SIDING

- Sheet Metal Roofing cont.:
- The roofing is held to the sheathing or decking with metal cleats attached to the roof and spaced about 12" apart.
- Continuous cleats are often used at the eaves, rakes (gable ends), and flashing. In all cases, cleats, nails, and other fasteners must be of the same type of metal to avoid galvanic action.






# PREFORMED ROOFING AND SIDING

- Preformed Roof and Wall Panels:
- Preformed panels are shaped pieces of metal or assemblies of metal facing with insulation between that are self-supporting and span intermediate supports. Roof panels span purlins, and wall panels span horizontal girts.
- The simplest preformed panels are simply corrugated or fluted sheets of metal of standard widths and varying lengths. They are assembled by lapping one corrugation at the edges and overlapping the ends. Preformed panels are also made as sandwich assemblies with insulation between two finished faces, joined with interlocking edges and a weather seal. Common widths are 24, 30, and 36" although others are available. These types of sandwich panels are fabricated in lengths to match the requirements of the job and usually reach from the foundation to the roof framing in one-story buildings. If two panels must be placed end to end, they are butt-jointed with flashing between.

# PREFORMED ROOFING AND SIDING

- Preformed Roof and Wall Panels cont.:
- Preformed panels are made primarily from aluminum, galvanized steel, and porcelain enamel steel. They are attached to framing with screws, clips, and proprietary fasteners. They are durable, easy and quick to install, and do not require on-site finishing.
- For industrial buildings and some other types of structures, a sandwich panel can serve as the interior finish as well as the exterior finish. However, preformed panels are most economical when used on large, flat, unbroken expanses of walls or roofs.

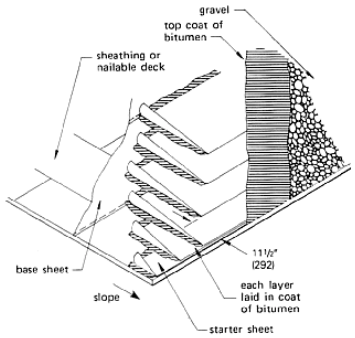


# MEMBRANE ROOFING

- Membrane roofing includes those materials applied in thin sheets to nearly flat roofs. It also includes liquid-applied products that can be applied to any roof slope. Although some manufacturers claim that their products are suitable for flat roofs every roof should have at least a 1/4"/ft slope to avoid standing water and the possibility of ponding.
- Ponding occurs when standing water or snow causes a flat roof to deflect a little, allowing more load to collect that causes more deflection that, in turn, allows more load to collect. The process continues until the roof fails.

# MEMBRANE ROOFING

- Built-Up Bituminous Roofing:
- Built-up roofing consists of several overlapping layers of bituminous saturated roofing felts cemented together with roofing cement. The bituminous material can be either asphalt or coal-tar pitch.
- Built-up roofs can be installed over nailable or non-nailable decks; the exact construction procedure changes slightly depending on which type is present. For nailable decks, a base sheet of unsaturated felt is nailed to the deck and covered with a coating of roofing cement. On non-nailable decks, the base sheet is omitted and a base coat is applied.






# MEMBRANE ROOFING

- Built-Up Bituminous Roofing cont:
- Three, four, or five layers of saturated roofing felts are then laid on top of each other, each layer bedded in roofing cement so that felt does not touch felt. The number of layers is determined by the type of deck used and the length of guarantee period desired. Five-ply roofs provide the most protection.
- A final coating of bituminous material is placed over the entire roof and covered with gravel or crushed slag. The purpose of the gravel is to protect the roofing from sunlight and other effects of weathering.

Image Source: Tremco Inc. Beachwood, OH./ http://wwwmangoldroofing.com, May 2008.

# MEMBRANE ROOFING

- Built-Up Bituminous Roofing:
- A variation of the built-up roof is the inverted membrane roof. Here, the built-up roof is placed on the structural decking and rigid, closed-cell insulation is placed over the roof rather than under it. The insulation is held down with gravel ballast.
- The purpose of this type of construction is to protect the membrane from the normal deleterious effects of expansion and contraction, drying, ultraviolet rays, and foot traffic that can cause leaks.



# MEMBRANE ROOFING

- Built-Up Roofing Details :
- As with any roof, built-up roofs must be designed to provide for positive drainage. As previously mentioned, the minimum roof slope should be 1/4 inch per foot.
- Nearly flat membrane roofs may be drained to interior drains, to perimeter drains, or to gutters on the low side of the roof. Crickets should be used to provide positive drainage in all directions.

# MEMBRANE ROOFING

- Built-Up Roofing Details cont.:
- When a roof is surrounded on four sides with a parapet or walls, there should be scuppers (also called overflow drains) through the parapet, nositione with their low edge slightly above the top of the root to provide a second means of drainage should the primary drains become clogged. These are usually required by codes.
- At the intersection of the roof and any vertical surface such as a wall or parapet, continuous triangular cant strips are placed in the intersection to provide positive drainage away from the joint and to give a smooth transition surface for the installation of the flashing at these points.



# MEMBRANE ROOFING

- Single-Ply Roofing:
- Single-ply roofing is a single-membrane layer of various types of materials. Because the quality of built-up roofing is labor intensive and largely dependent on proper installation, single-ply roofing has come into widespread use.
- Although it too must be applied carefully, there are usually fewer installation problems. In addition, single-ply roofing is more resistant to slight building movement and the damaging effects of the weather.

# MEMBRANE ROOFING

- Single-Ply Roofing cont.:
- There are several types of single-ply membranes. Modified bitumens are sheets about 50 mils (1.3 mm) thick that are composed of bitumen, a chemical additive to enhance the elastic properties of the bitumen, and a reinforcing fabric to add tensile strength. The bitumen sheet is laid over insulation or insulating decks with a separator sheet between the deck and the membrane.
- These sheets allow the roof to move independently of the structure, and some sheets are designed to allow water vapor from the building to escape to the perimeter of the roof. To anchor the membrane and protect it from ultraviolet degradation, the surface is covered with gravel ballast.
- Other types of membranes include ethylene propylene diene monomer (EPDM), polyvinyl chloride (PVC), and chlorinated polyethylene (CPE).

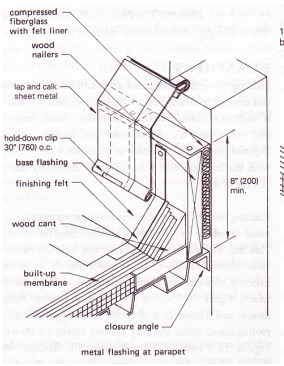


# MEMBRANE ROOFING

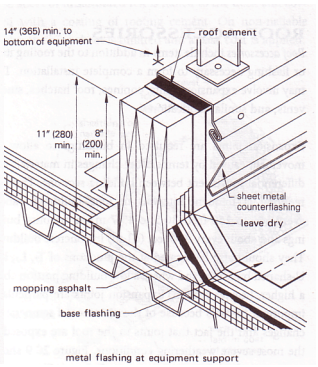
- Elastic Liquid Roofing:
- Liquid-applied roofings include butyl, neoprene, hypalon, and other products They are applied in liquid form in one or two coats by brushing or spraying and air-cured to form an elastic, waterproof surface.
- Liquid-applied membranes are also used for below-grade waterproofing on foundation walls, tanks, and pools, and for similar applications. These products are particularly suited for roofs with complex shapes such as thin-shell concrete domes.

# FLASHING

- Flashing prevents water penetration and directs any water that does get into construction back to the outside. Flashing is made of galvanized steel, stainless steel, aluminum, copper, plastic, and elastomeric materials.
- Material selection depends on the other metals or materials it is in contact with, the configuration of the joint, the durability desired, and the cost.



metal flashing at parapet

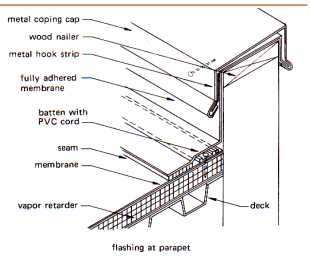


metal flashing at equipment support

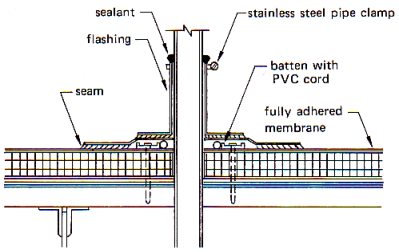


# FLASHING

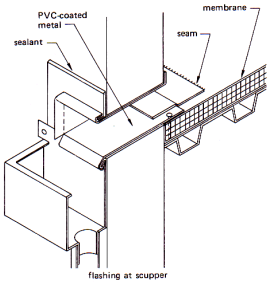
- Flashing protects joints wherever water penetration is anticipated or where two dissimilar surfaces meet at an angle. This may include the areas where roofs intersect parapets, areas above windows, above steel lintels supporting masonry, between butt joints of preformed siding, and elsewhere.



flashing at parapet



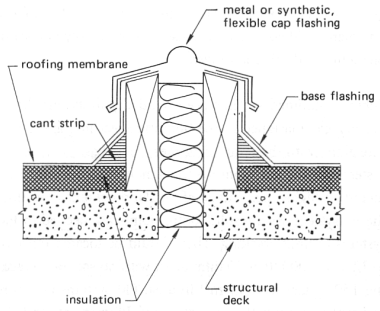
flashing at roof penetration



flashing at scupper

# ROOF ACCESSORIES

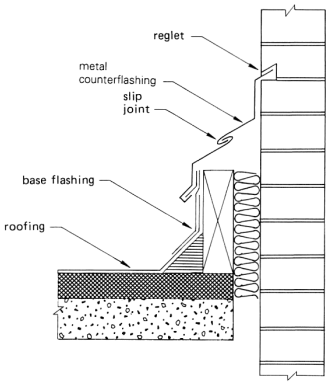
- Flashing Roof accessories include items in addition to the roofing itself or flashing necessary to form a complete installation. This may involve expansion joints, copings, roof hatches, smoke vents, and similar fabrications.
- Expansion joints are required in buildings to allow movement caused by temperature changes in materials and differential movement between building sections. They are required at frequent intervals in long buildings— about every 100 to 150 feet in masonry buildings and about every 200 feet in concrete buildings.





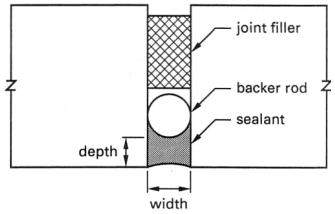

# ROOF ACCESSORIES

- Expansion joints should also be located at the junctions of T-, L-, and U-shaped buildings and where a low building portion abuts a higher, heavier section.
- Expansion joints are particularly important in roofs because of the extremes of temperature changes and the fact that joints in the roof are exposed to the most severe weathering conditions.
- Smoke vents are devices that allow excess smoke to escape in the event of a fire. Exact requirements for location and size of smoke vents are given in the various model building codes, but in general they must be located in hazardous occupancies, in certain business occupancies over 50,000 ft^2 over stages, and above elevator shafts. Vents are designed to release automatically in the event of fire, usually by being spring-loaded and connected to a fusible link.



# CALKING AND SEALANTS

- Expansion Sealants are flexible materials used to close joints between materials. The word "sealant" is the more correct term, but the word "calking" is often used to designate low- performance sealants employed where little movement is expected, such as between a window frame and an exterior wall. Sealants must be capable of adhering to the joints while remaining elastic and weatherproof.
- There are several types of sealants, each with slightly different properties and uses under various conditions. Sealants are classified as low, intermediate, and high performance, depending on the maximum amount of joint movement they can tolerate.






# CALKING AND SEALANTS

- Low-performance sealants are used in joints with plus or minus 5 percent movement, intermediate-performance sealants for plus or minus 12.5 percent movement, and high-performance sealants for joints with up to about 25 percent movement.
- The width and depth of a sealant are critical to its proper performance. The width is determined by the expected joint movement. The depth should be equal to the width for joints up to 1/2 wide; for joints from 1/2" to 1", the depth should be 1/2". For wider joints, the sealant depth should not be greater than one-half the width. Joint fillers are used behind the sealant to control the depth of the sealant.