CHAPTER 7 Exterior

BUILDING ENVELOPE

INTRODUCTION

An envelope is that which envelopes or is a natural enclosing covering such as a membrane or a shell. Applying this definition to a building, the term building envelope is the collection of walls, floors, roofs, windows and doors that separate the interior environment from the exterior environment.

The function of the building envelope is to ensure a comfortable living environment indoors, by excluding undesirable external elements, while permitting some control over internal conditions.

There are a number of influences on the building envelope that the envelope must be equipped to deal with as a part of its functions. Some of these influences originated from the exterior of the house and some from the interior of the house.

Heat Transfer

The building envelope slows down the transfer of heat being lost through the envelope.

Humidity and Condensation

The building envelope must be able to prevent excessive amounts of moisture from penetrating the exterior wall from the interior. If humid air enters the wall cavity, the moisture can condense as the temperature decreases and the dew point is reached. This moisture will cause framing members to rot.

Ventilation Control

All homes require a certain amount of ventilation to remove humidity, provide fresh air for combustion and to prevent excessive build-up of indoor pollutants. The resistance of the building envelope to air leakage has a direct bearing on whether mechanical ventilation needs to be provided or if the envelope is sufficiently “leaky” to provide the necessary air change.

Entry of Wind Driven Cold Air

Wind driven cold air entering the house can cause air movement that decreases the efficiency of the insulation. It can also create cold air currents in the home which can add to the heating load of the home and cause discomfort to the occupants.

Entry of Wind or Gravity Driven Water

The exterior finish material should be carefully designed and applied to prevent water penetration from the outside, which can cause premature rotting and deterioration.

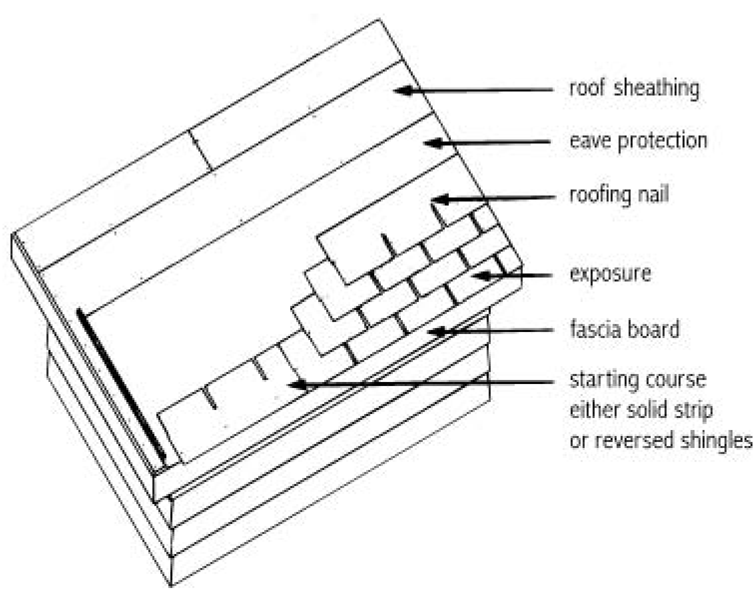
Climatic Changes

The building envelope must be impervious to climatic cycles of freeze/thaw, wet/dry, hot/cold and rain/snow.

ROOFING

Roof coverings should provide a long-lived, waterproof finish that will protect the building and its contents from rain and snow. Many materials have withstood the test of time and have proven satisfactory under various service conditions.

Asphalt singles are by far the most commonly used covers for pitched roofs. Wood and sawn cedar shingles, hand-split shakes, tile and slate, roll roofing, galvanized steel, aluminum, copper and tin are also used. For flat or low-pitched roofs, built-up roofing with a gravel topping or cap sheet is frequently used. The choice of materials may be influenced by cost, local code requirements or local preferences based upon past experience.

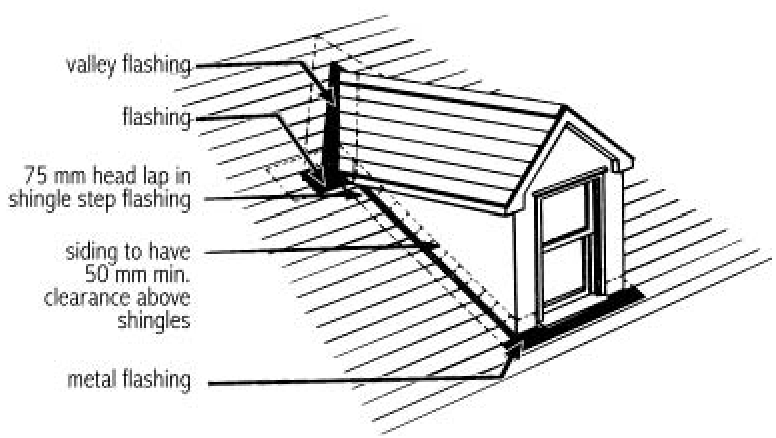


In shingle application, the exposure distance is important and the exposure depends on the roof slope and the type and length of shingle used. The minimum slope on roofs is 2 in 12 for asphalt shingles (using a low slope application), 3 in 12 for wood shingles and 4 in 12 for asphalt shingles (using normal application), hand-split shakes and cedar shingles. Built-up roof coverings are rarely used on roofs where the slope exceeds 3 in 12.

In order to avoid water damage, caused by melting snow which sometimes forms into ice dams at the eaves, shingle or shake-covered roofs should have additional protection when the overhang is less than 3 feet long. This protection usually consists either of 45-pound rolled roofing laid with the joints lapped at least 4 inches and cemented together or by 2 plys of 15 pound asphalt roofing felt (perforated) cemented together. Placed over the eaves on the roof sheathing, this protective sheet extends from the edge of the roof to a line at least 12 inches inside the inner face of the exterior walls, thus providing a watertight capping at the edge of the roof to counteract ice damming.

Flashing is provided where necessary to prevent the entry of water at junctions between roof and walls, roof and chimney, roof valleys and where stacks or vents penetrate the roof.

The selection of the most suitable flashing material for each specific location is important, as is the proper installation to prevent water leakage.



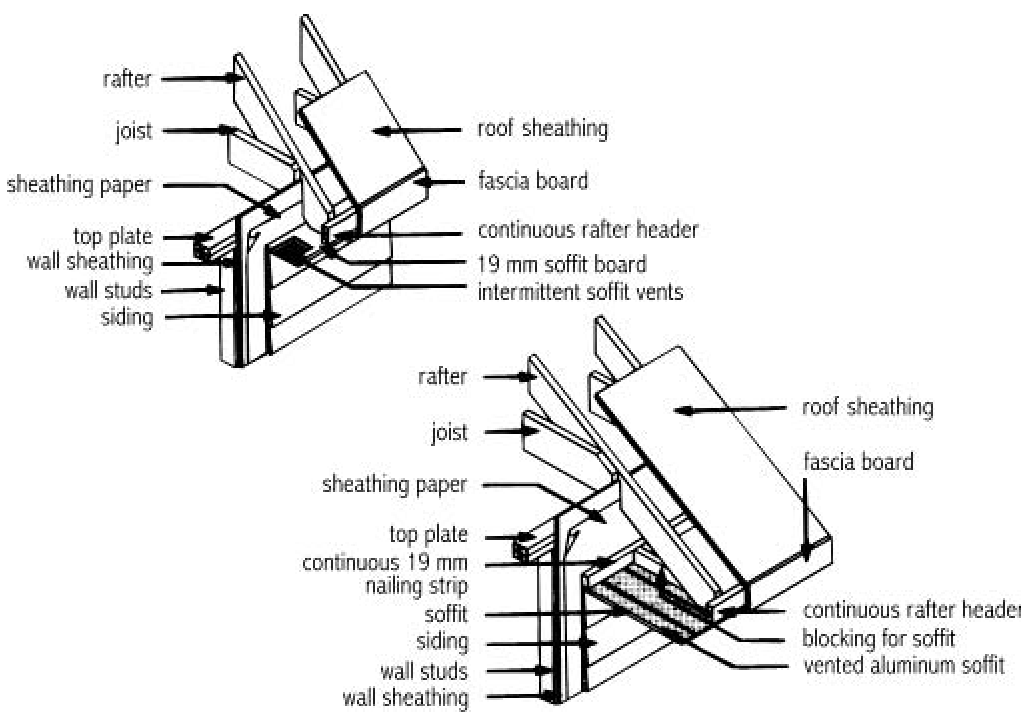
Eavestroughs (gutters) and downspouts are used to reduce the collection of groundwater adjacent to the foundations. To some degree they also protect the exterior wall finish. Eavestroughs are commonly made from metal (steel or aluminum), although plastic is sometimes used.
The eavestroughs are installed at the horizontal roof edge. They are mounted on the fascia board with a slight slope towards the downspouts. The downspouts may be connected to a storm sewer or may empty onto a splash pad used to direct the water away from the foundation wall.

SOFFITS AND FASCIA

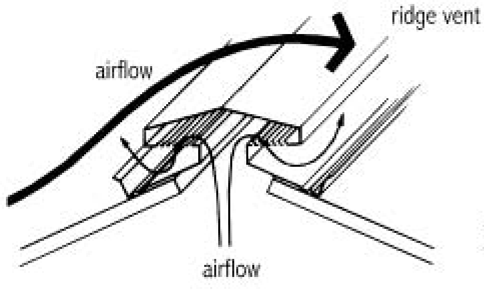
The eave is formed by the roof overhang and provides a finished connection between the wall and the edge of the roof. This overhang provides shade for window areas, protects the walls and adds attractiveness to the structure.

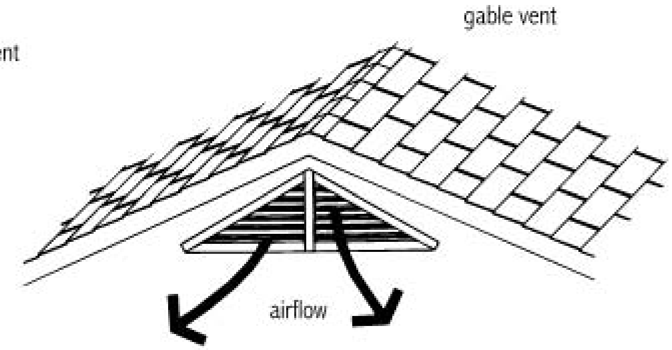
The fascia is the trim member along the outside edge of the roof. The soffit is the horizontal covering on the underside of the eave.

The most common materials used for fascia and soffits are aluminum, vinyl, plywood or wood.



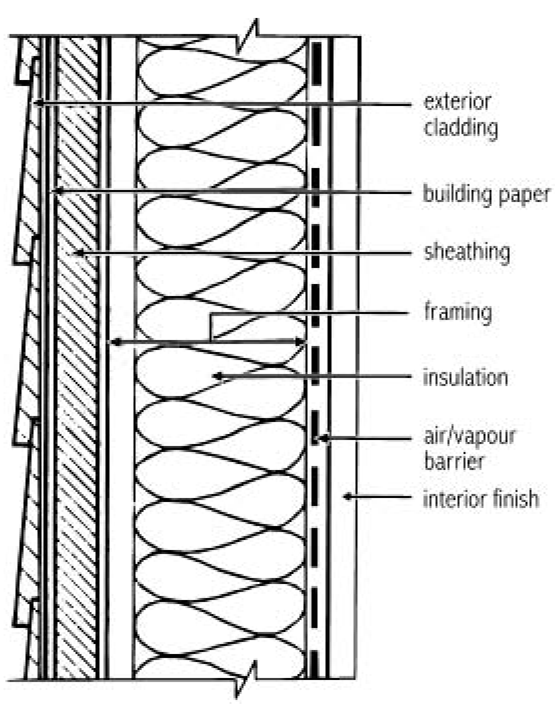
Soffits also must function as vents in conjunction with some type of roof vents to provide ventilation for the attic.





EXTERIOR WALL FINISH

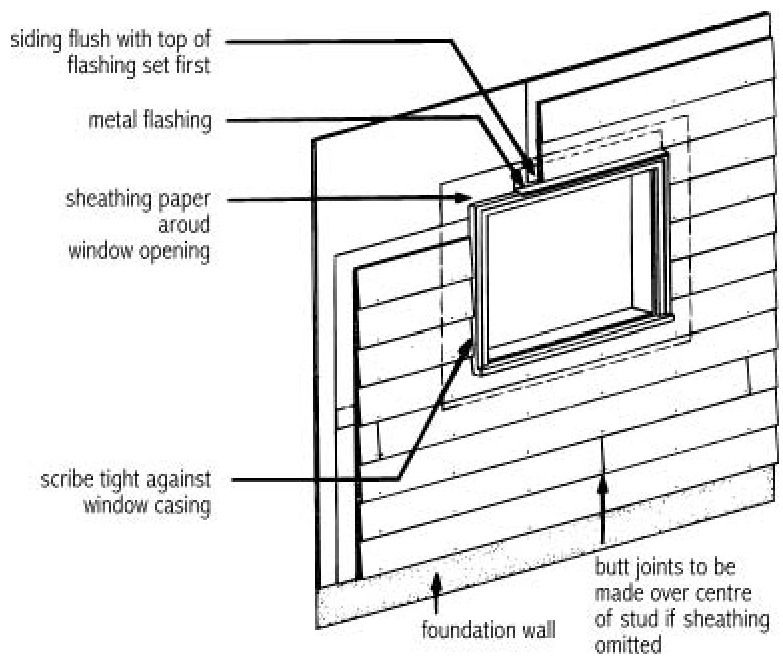
The function of the exterior wall finish is to repel the entry of wind and water into the dwelling unit and provide a skin or protective layer to protect other systems from deterioration. The wall should repel water but must also allow water vapour entering the wall section from the interior to escape. Most exterior wall finishes are composed of building paper and siding.



Building paper is used on the exterior wall between the exterior finish and the sheathing. This air barrier cannot also be a vapour barrier because any moisture trapped in the wall cavity would not be able to escape. The two most common types of air barriers are building paper (asphalt impregnated felt) and tyvek (spun olefin plastic).

Wall sheathing provides racking strength to the wall system, back-up strength for siding and helps prevent the entry of drafts and wind.

Materials used for siding include lumber, wood shingles and shakes, plywood, hard-pressed fibreboard, particleboard, metal (steel or aluminum), vinyl, stucco and masonry.



Wood board siding may be applied vertically or horizontally (drop siding). Corner boards are generally used with drop siding, although they may also be used with other types. The corner boards are applied against the sheathing, with the siding fitted tightly against the narrow edge. All joints between the siding and corner boards should be finished with caulking compound when the siding is applied.

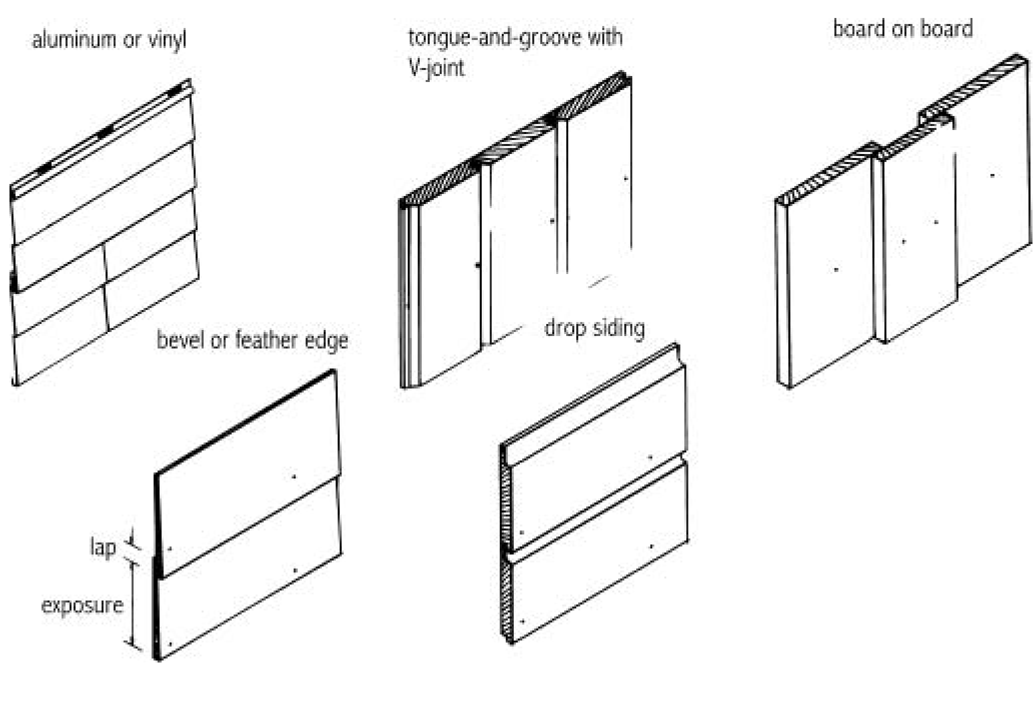
Mitred corners must fit tightly and smoothly to the full depth of the mitre. The ends are often set in caulking compound or putty when the siding is applied. To maintain a tight fit at the mitre, it is important that the siding be properly seasoned before delivery and protected from rain when stored on the site to minimize shrinkage after installation.

When installing plywood and hard-pressed fibreboard, the corners are usually lapped or fitted to a corner board. Lumber siding applied vertically is always lapped at the corners.

A wide variety of paints, stains and other coatings are available for exterior use. Good quality materials should be selected as the cost of the materials is nearly always a small proportion of the total cost of painting, and it is false economy to use poor quality materials. It is usually advisable to apply one coat of wood sealer or stain to the backside of the wood siding to help preserve it.

Clear coatings that provide a protective film over the surface of wood are adversely affected by direct sunlight and have a short life expectancy of perhaps one or two years on surfaces exposed to the sun's rays. Direct sunlight causes the film to disintegrate and fall off in patches, leaving parts of the wood exposed. As the parts of the film that remain are hard and brittle, preparation of the surface for recoating is difficult. Coloured stains soak into the wood leaving no visible film on the surface and protect all sides of the house for a much longer period of four years or more. Recoating over coloured stains is also much easier as it can be done with a small amount of surface preparation.

Surfaces to be painted should be clean and free from substances that will interfere with the adhesion of the paint. After the prime coat is applied, nail holes, cracks and other defects should be filled with putty or a suitable filler. The surface to be painted should be dry. Painting should not be carried out in temperatures below 4(C (40(F). Paint does not hold well on plywood exterior cladding, and the plywood should therefore only be covered with a solid or pigmented stain.



Hard-pressed fibreboard (hardboard) is produced in sheets. As with plywood, it may be installed in panels or in strips as lap siding. Always fasten hardboard to the framing member or to lumber sheathing with corrosion-resistant nails and follow the manufacturer's instructions carefully.

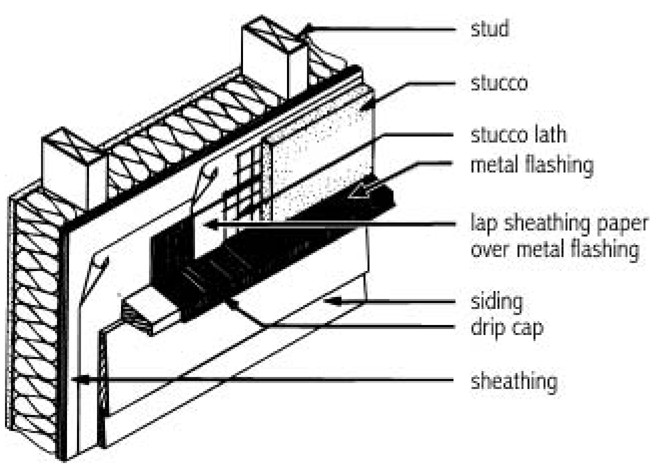
Metal siding is produced in a variety of shapes and patterns. Some simulate the appearance of wood bevel siding or vertical board and batten. Most siding materials have factory-finished surfaces and are available in a variety of colours.

Aluminum siding should be effectively coated or separated from masonry to avoid deterioration by the lime in the masonry materials. Apply metal siding in accordance with the manufacturer's instructions.

Vinyl siding is available in a variety of profiles, colours and surface patters. Colours extend through the thickness of the vinyl material which eliminates most maintenance problems.

Stucco generally consists of a mixture of Portland cement and well-graded sand with hydrated lime added to make the mixture more workable. Masonry cement may be substituted for the lime.

The stucco is applied in three coats (two base and one finish), and held in place by stucco lath or some other type of reinforcement. The finish coat may be left the natural cement coloured by the addition of pigments or be a stone-dash finish. For a stone-dash finish, mineral chips are partially embedded in the second coat before it has set.



If stucco is broken or damaged it may be repaired, although it is often difficult to match the appearance of the original and a brush coat over the entire surface may sometimes be necessary. If applied in dry, warm weather, fresh stucco should be kept damp to ensure proper curing. In cold weather, each coat of stucco should be kept at a temperature of at least 10(C (50(F) for 48 hours after application.

Brick and stone are applied as a veneer to the outside of the building. All structure loads are supported by the wood frame wall, leaving the brick or stone to act only as an exterior finishing material .

Brick veneer must be supported by an extended width of the foundation wall, by steel angle iron anchored securely to a concrete foundation. A one inch air space must be provided between the veneer and wood frame wall. The brick veneer is tied to the wood wall with rustproof, corrugated metal ties nailed through the sheathing to every other stud and laid into the mortar joints about every 18 inches of vertical height.

Parging is applied to the section of concrete foundation that extends above grade. Parging is the grey coloured stucco scratch coat applied directly to the concrete or over stucco wire on wood foundations. Whether you have siding or stucco, parging should be applied from the grade line up at least 8 inches. The parging can be applied in a variety of finishes such as a drag coat, trowel design or sectioned off in a rectangular design. In areas where stucco-covers are not readily available, paint-on deck coatings can be successfully used in place of stucco.

EXTERIOR DOORS

The function of exterior doors is to permit entry and exit of the occupants, while preventing entry of water, wind and intruders when closed .

Main entrance doors are generally 3’0” x 6’8” x l-3/4” thick, while secondary entrance doors may be only 2’8”- 2’10” wide. Differences in humidity or temperature on opposite sides of a door tend to cause twisting and warping. For this reason, exterior doors should be of a solid core construction. Metal or wood storm doors also help prevent warping, with the added advantage of reducing wind-driven air entry and lowering heat loss.

Panel doors consisting of solid vertical members, solid cross members and panels are available in various styles and woods.

A solid core, flat door is made with plywood over a framework with a core built from solid pieces of wood. Metal or plywood-faced doors whose cores are filled with rigid insulation are suitable for use whenever a separate storm door is not provided. Steel doors offer the advantage of low maintenance and often use a magnetic weatherstripping which is very effective. Door weatherstripping is critical because of constant use and abuse. Select adjustable material that creates a good air seal without having to use excessive force to close the door. Weatherstripping for door bottoms must be durable as they are subject to traffic wear. Usually only the vinyl or rubber parts become worn. Check to see if new inserts can be purchased separately.

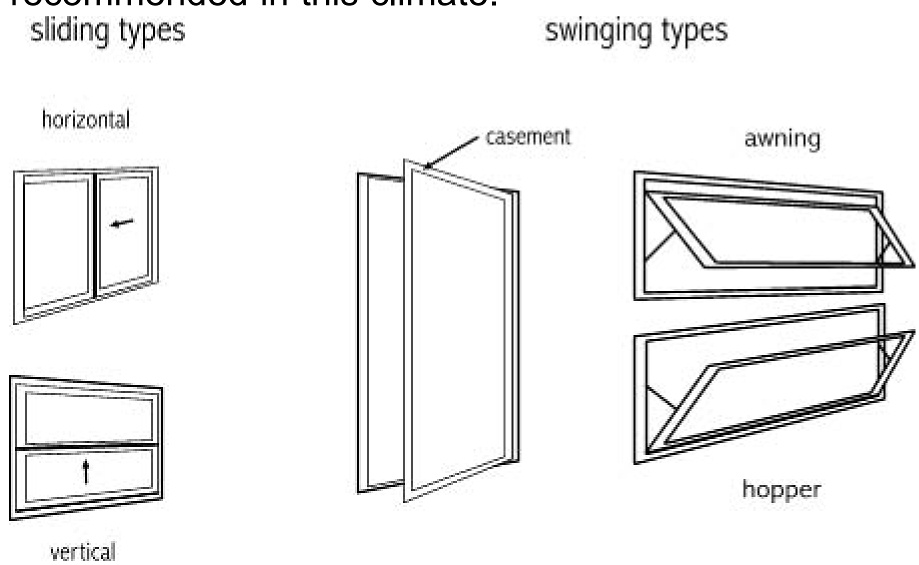
WINDOWS

Windows are intended to provide light, ventilation and view without permitting the entry of wind or water.

In general, windows can be classified under three basic headings:

1. Sliding
2. Swinging
3. Fixed

Each of these includes a variety of designs or methods of operation and may be used in combination. Sliding windows include both vertical and horizontal types. Sliding glass doors are essentially large horizontal sliding windows. Sliding windows are not recommended in this climate.



Swinging windows are known as casement windows when they are hinged on a vertical line. Awning or hopper windows are hinged on a horizontal line. Swinging windows are simple to operate, easy to clean and vary in how far they will open. They offer very little rain or wind protection.

The three principal parts of a window are the frame, the sash and the glass. The frame is the outer part of the window which is solidly fixed to the wall framing. The frame supports the sash, which in turn carries the glass. The sash may be fixed in position or may be designed to open. There may be more than one sash in a frame arranged so that only one is operable. Fixed and operable windows are often combined in large window areas such as a living room. These combinations allow ventilation to what is often a large dead air volume on a hot summer day. Of course, any type of ventilating window will require screens to keep out insects.

In addition to glass, windows and doors are constructed of wood, metal, plastic or fibreglass. There are inexpensive and expensive types available in any material. Windows are components where cheapness will show up quickly with poor operation, draftiness, condensation problems and general disrepair. Well-built units with proper weather sealing and durable hardware are well worth the expense. They lower heat losses, allow for ease of operation, minimize condensation build-up, provide general longevity and minimum maintenance.

Wood windows offer good insulation properties, but must be treated against the elements - a continual maintenance factor. Vinyl or metal covering over a wood core or solid vinyl offers an excellent maintenance-free, well-built window unit. This type of construction is, however, more expensive than “paint yourself” frames.

Metal sashes (aluminum or steel) also come in protective, long lasting finishes. They are stronger than wood, enabling thinner sections. They are, however, susceptible to higher heat losses and condensation. Metal sash and frames with proper thermal breaks included (to lower heat loss and condensation) may cost as much as vinyl clad wood units. Sliding glass doors are subject to the same conditions as windows.

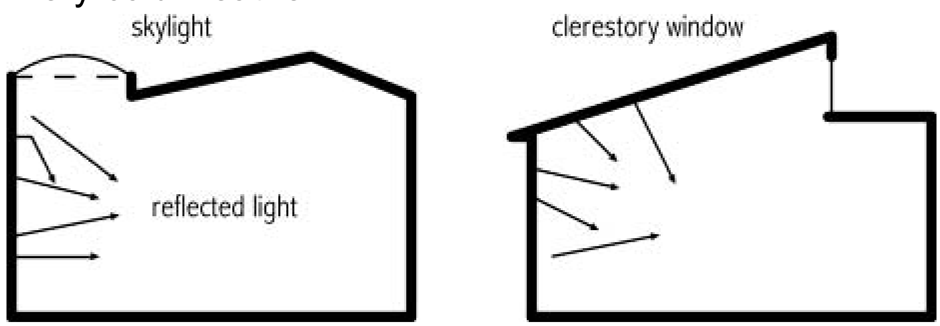
The insulation value of windows is very low. The glass itself can be insulated by utilizing a double pane or a sealed double-glazed unit. This sealed unit may be filled with special gases to increase thermal efficiency. Double glazing of some sort should be viewed as a minimum requirement. Triple glazing can improve the insulation value but at increased initial cost. In very cold climates, triple glazed window systems are well worth the extra initial cost in terms of energy savings and comfort. A great amount of heat loss in windows can be attributed to air leakage. Careful caulking of fixed units and sealing techniques used on operating units is vital for air leakage control. As well, sealing the window from the interior vapour barrier is critical.

The quantity of light a window admits depends on its size, shape, orientation, amount of outside light, the time of day and adjacent outdoor surfaces. That a larger area window admits more light than a smaller area window is logical, but shape also is an important factor. A tall, vertical window will generally give deeper penetration of daylight into a room than a long, horizontal window of identical area. Orientation, amount of outside light, time of day and time of year affect the quantity of light being passed through an opening.

The natural light which enters a home is made up of direct sunlight, skylight and reflected light. One has to consider various orientations for the house and windows in order to pick and choose among the different qualities of light wanted in a room at a given time of day. “Sunlight” is direct and produces sharp shadow and brightness contrasts. “Skylight” is diffused, soft and directionless when filtered through an overcast sky. “Reflected light” from other surfaces combined with skylight plays down contrasts and makes details easier to see. Colour and texture of walls and floors play a large role in the quantity of light at any point in a room. Light coloured surfaces reflect more light and increase the apparent

light in a room, thereby making it seem larger. The rear wall and ceiling surfaces in a deep room will appear darker than other areas of the same colour. Unless they are of a light colour, the room may seem gloomy.

Top lighting with skylights or clerestory lighting, or crosslighting with other windows on adjacent or opposite walls can give more even illumination and reduce shadows and glare. However in Northern areas, skylights are somewhat ineffective. With low winter sun angles they capture little light and can contribute to overheating when the sun angle is high in summer. They also have condensation problems in very cold weather.



When deciding on windows for your home, sufficient attention to design details are critical. The most obvious feature of window design is the external appearance. A well designed exterior finishing scheme will do much to enhance the character of a home, but there are other factors to consider - both externally and internally. The outward view from the inside is as important as the external position of the actual opening. Problems with regard to ventilation and natural light must also be answered. To replace the need for a screen door a side panel window (opening for ventilation) can be used to provide natural light and air. By using an insulated door, heat loss is not a problem. Translucent glass can be used for privacy, in locations where that is important.

Internal functions must be satisfied. Windows primarily offer natural lighting, ventilation and a means for seeing out. Proper ventilation and consideration of the view out are important factors to consider. Openings should be located so as to provide through ventilation during warm weather and still maintain the ability to provide fresh air with little or no draft in the winter. Considerations to the view include who will be looking out. Sill heights from 4’6” to 5’6” are usable only if extreme privacy is wanted. Normal sill heights of 2’0” to 3’6” are used for most windows. However, persons sitting on low chairs or children require lower sill heights (from 1’ to 2’0”) to adequately see out or operate openers.

Rather than accept “standard” window sizes and shapes, considerations of surrounding area, room function, prevailing weather conditions, natural light and aesthetics should be used to select window sizes, shapes and locations. Uniformity in window style and operation will aid in the overall final appearance of the home. Too many types or sizes of windows on any one side are common exterior design problems.

INSULATION

An important function of the building envelope is to slow down the transfer of heat. Canadian winters are cold, so we add a heating system to our houses to try to overcome that cold. As well, we try to build our houses in such a way that the heating system is not heating the outdoors. We try to keep the heat in! This is the job of insulation. Heat tends to do things which work against this goal. Basically, it “flows” from areas of warmth to areas of cold. Many people believe that since hot air rises, most heat loss will be through the ceiling; not necessarily so. Heat moves in any direction - up, down and sideways - as long as it is moving from a warm spot to a colder one. Insulation should attempt to block the flow of heat - in all directions.

Although common structural materials do have some resistance to heat flow, the addition of specialized insulation materials is required to bring heat loss down to manageable levels. Wood-frame construction is quite easy to insulate since it incorporates many cavities which can be readily filled with insulation. It has become apparent that insulation should at least fill all available cavities within the building shell, and that perhaps the shell construction should be altered to accommodate even more insulation. Concrete foundation walls are more difficult to insulate, but since they are a major source of heat loss they should not be overlooked.

The R-value (imperial) or RSI-value (metric) is a measure of a material’s ability to resist heat flow. The higher the RSI (R) value, the better the material insulates. There are four basic types of insulation: batt or blanket, loose fill, rigid and foamed in place. The following chart summarizes the different types of insulation and their application.

TYPE	MATERIAL	(R/in.)	APPLICATION	ADVANTAGES	LIMITATIONS
BATT OR BLANKET	**Glass Fibre**	RSI/mm 0.022 R/in. 3.2	Accessible attic floors uncovered frame walls above and below ground level storage tanks, heating ducts piping	• Easy to install in open cavities • Lightweight • Non-settling	• Little resistance to air infiltration
	Mineral Wool	RSI/mm 0.023 R/in. 3.3	Accessible attic floors uncovered frame walls above and below ground level storage tanks. heating ducts piping	• Easy to install in open cavities • Dries with little effect on RSI (R) • Friction fit batts are relatively non-combustible • Non-settling	• Little resistance to air infiltration
LOOSE FILL (BLOWN)	**Cellulose Fibre**	RS1/mm 0.025 R/in. 3.6	Attics; enclosed cavities such as roofs, walls, floors. Not acceptable for use below ground level	• Easily fills irregular horizontal spaces • Higher resistance to air infiltration than most loose fill insulation materials when installed at a density of	• Could settle in wall cavities if not blown to a minimum density of 56 kg/m3 (3.5 lbs./ft.3) 56 kg/m3 (3.5 lbs/ft.3)
	Glass Fibre	RSI/mm 0.020 R/in. 2.9	Attics: enclosed cavities such as roofs walls. floors. Not acceptable for use below ground level	• Easily fills horizontal spaces • Lightweight	• Tends to get caught on nails in enclosed cavities • Little resistance to air infiltration • May settle after application if not properly installed
	Mineral Wool	RSI/mm 0 019 R/in. 2.7	Attics: enclosed cavities such as roofs. walls. floors. Not acceptable for use below ground level	• Easily filLs irregular horizontal spaces • Non-combustible • Shorter fibres reduce the tendency to get caught on wires and nails in enclosed cavities	• Little resistance to air infiltration • May settle if not properly installed
LOOSE FILL (POURED)	**Cellulose Fibre**	RSI/mm 0.024 R/in. 3.4	Attics; sloped roofs; accessible enclosed wall cavities. Not acceptable for use below ground level	• Easily fills irregular horizontal spaces	• Settles
	Glass Fibre	RSI/mm 0.021 R/in 3.0	Attics and accessible enclosed wall cavities Not acceptable for use below ground level	• Easily fills irregular horizontal spaces • Lightweight	• Settles
	Mineral Wool	RSI/mm 0.021 R/in. 3.0	Attics and accessible enclosed wall cavities. Not ground level	• Easily fills irregular horizontal spaces • Non-combustible	• Settles
	Vermicu-lite	RSI/mm 0.016 R/in. 2.3	Attics and accessible enclosed wall cavities. Not acceptable for use below ground level	• Pours more easily into irregular wall cavities than other loose fill insulation • Non-combustible	• Absorbs moisture and dries slowly

NOTES:

- I in = 25.4 mm
- The RSI (R) value is a measure of a materials ability to resist heat flow The higher the RS1 (R) value, the better the material insulates.
- The RSI (R) values quoted in this fact sheet are averages for the materials listed and are representative values only Individual products may vary: be sure to check the packaging.

TYPE	MATERIAL	RSI/mm (R/in.)	APPLICATiON	ADVANTAGES	LIMITATIONS
RIGID BOARD	**Glass Fibre Board**	RSI/mm 0.029 R/in 4.2	Roofs; ceilings; floors; interior/exterior face of wall, above and below ground level. Ducts. Pipes	• Available in a variety of thicknesses, densities and special finishes • Permeable to vapour flow (does not act as vapour barrier)	• More compressible than other rigid board insulation • Care mast be taken when applying exterior finish materials
	Low Density Expanded Poly-styrene (beadboard)	RSI/mm 0.026 R/in 3.7	Roofs; ceilings; interior face of wall above and below ground level. Exterior face of wall. above ground level	• Lightweight • Available in a variety of thicknesses • Permeable to vapour flow (does not act as a vapour barrier)	• Must be protected from exposure to sunlight and solvents • Fire hazard if not properly protected
	High-Density Expanded Poly-styrene	RSI/mm 0.028 R/in 4.0	Roofs; ceilings; interior and exterior faces of walls, above and below ground level. Under concrete slab foundations.	• Reasonably moisture resistant • Lightweight • Available in a variety of thicknesses Permeable to vapour flow (does not act as a vapour barrier.)	• Must be protected from exposure to sunlight and solvents • Fire hazard if not properly protected
	Extruded Poly-styrene	RSI/mm 0.035 R/in 5.0	Roofs; ceilings, interior and exterior faces of walls, above and below ground level. Under concrete slab foundations	• Excellent moisture resistance • Can perform as a vapour barrier when installed on interior side of insulated cavities if joints are properly sealed	• Must be protected from exposure to sunlight and solvents • Vapour barrier characteristic may be a disadvantage when used as an exterior sheathing, unless a continuous Type I vapour barrier has been installed on the interior or warm side of the wall • Fire hazard if not properly protected
	Poly-urethane	RSI/mm 0.042 R/in. 6.0	Roofs: ceilings: interior and exterior faces of walls, above and below ground level	• Can perform as a vapour barrier when installed on interior side of insulated cavities if joints are properly sealed	• Can be affected by excessive temperature conditions • Vapour barrier characteristic may be a disadvantage, when used as an exterior sheathing, unless a continuous Type 1 vapour barrier has been installed on the interior or warm side of the wall • Fire hazard if not properly protected
	Phenolic	RSI/mm 0.029 R/in. 4.2	Exterior face of walls. above ground level	• Permeable to vapour flow (does not act as a vapour barrier) • Fire resistant	• Can be affected by excessive temperature conditions
FOAMED IN PLACE	**Poly-urethane Foam**	RSI/mm 0.042 R/in 6.0	Industrial- roofs; interior and exterior faces of walls. above ground level	• Can be applied to irregular surfaces such as prefabricated metal building	• Effectiveness highly dependent on installation techniques and conditions • Fire hazard if not properly protected • Should not be used in enclosed cavities due to its expansion characteristics. • Must be protected from exposure to sunlight and solvents

NOTES:

- Proper installation of blown loose fill insulation requires an experienced well trained technician.
- Although it is possible to insulate enclosed walls, which are open at the top, with pouring insulation. the difficulty in doing a proper job does not justify the application method in most cases.
- Cellulose fibre is regulated by Consumer and Corporate Affairs Canada. This ensures that all cellulose fibre sold meets strict guidelines for flammability, corrosiveness, smoulder resistance and chemical separation.
- A vapour barrier must be used with all insulation. It must be applied to the warm side of the insulated surface. All air leaks must be sealed to ensure vapour barrier continuity.
- All thermal insulation materials will suffer a loss of thermal resistance, to a greater or lesser degree, when wet. Most will dry with little effect on the RSI (R) value.

THERMAL RESISTANCE VALUES

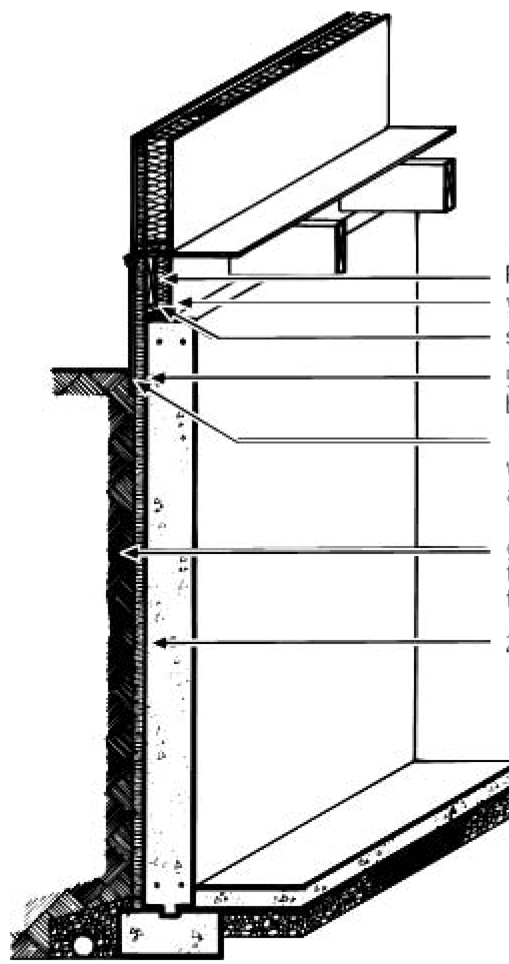
Material	R/inch	RSI/mm
Fibreglass batt	3.17	.022
Rock wool batt	3.32	.23
Fibreglass loose	2.16	.015
Rock wool loose	2.74	.019
Cellulose	3.61	.025
Vermiculite	2.31	.016
Polystyrene loose	2.88	.020
Expanded Polystyrene	3.89	.027
Extruded Polystyrene	4.62	.032
Polyurethane rigid	6.06	.042
Fibreglass sheathing	4.47	.031
Wood fibre	3.32	.023
Wood shavings	2.45	.017
Plywood sheathing	1.25	.008
Particleboard	1.25	.008
Insulating fibreboard	2.45	.017
Building paper	.06	.0004
Wood siding (3/4”)	1.06	.190
Clay brick (4”)	.42	.070
Stucco (S/8”)	.12	.020
Metal siding with backing	1.41	.250
Wood shingles	1.00	.180
Lumber	1.25	.008
Concrete (8”)	.06	.0004
Drywall (1/2”)	.45	.080
Plaster (1/2”)	.32	.050
Wood finish (3/4”)	.94	.170
Carpet (foam underlay)	1.29	.230
Carpet (fibre underlay)	2.09	.370
Single pane window	.85	.150
Double pane window	1.70	.300
Triple pane window	2.78	.490

All surfaces exposed to outside air, to unheated areas or to a garage (heated or unheated) should be insulated. The minimum amount of insulation levels is determined by the building codes, but these may not be sufficient for comfort and energy conservation purposes. The following levels reflect recent thoughts on how much insulation is practical from both a cost (payback) point of view and adaptability to standard construction methods. If higher levels are desired, be prepared to alter the framing techniques to accommodate more insulation.

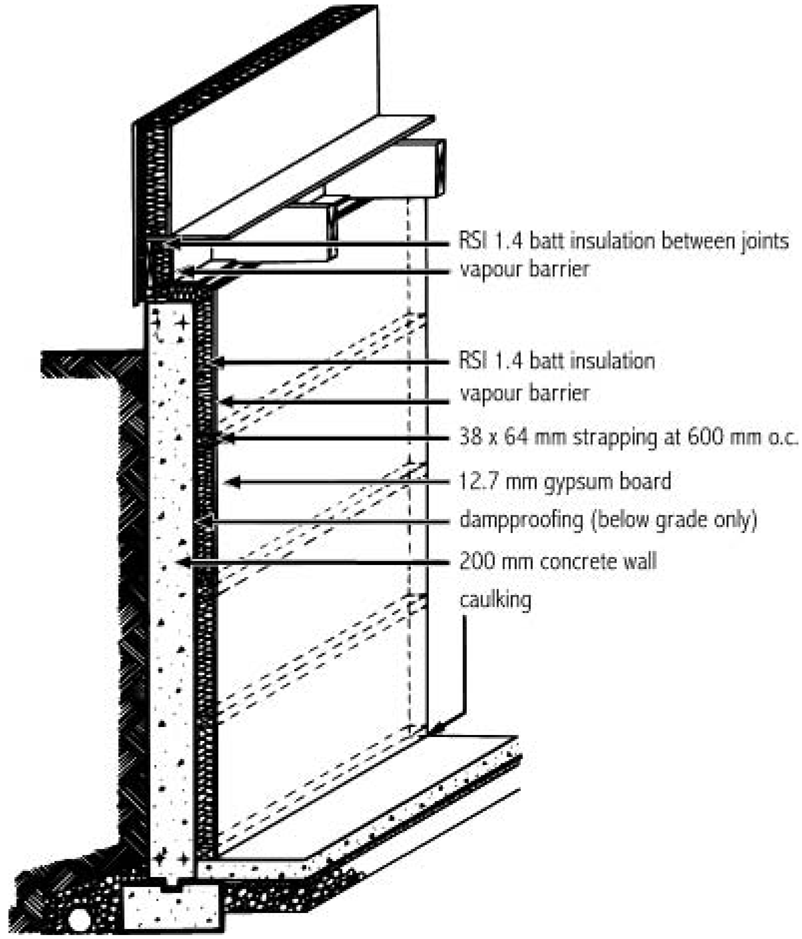
Walls	RSI 3.5	(R 20)
Basement	RSI 2.1	(R 12)
Roof or Ceiling	RSI 6.3	(R 36)
Floor (over unheated spaces)	RSI 4.9	(R28)

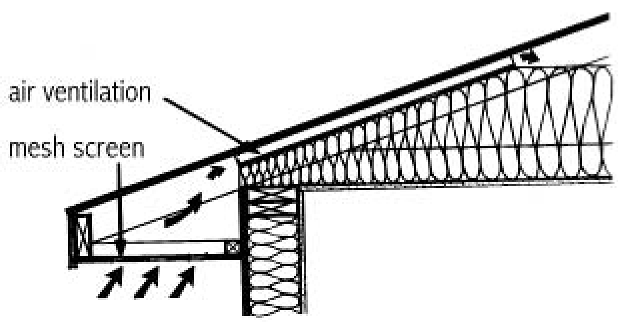
The following diagrams illustrate various techniques used for the installation of insulation.

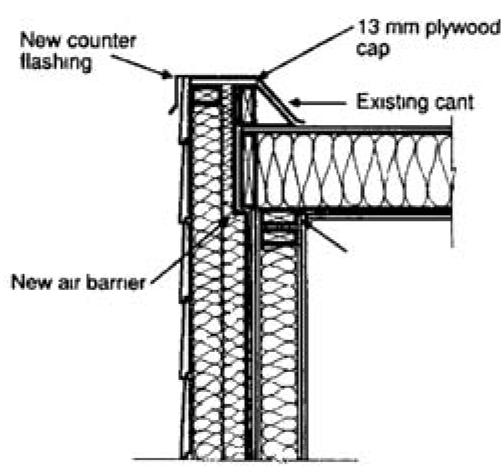
Component	**RSI value**
outside air film	0.030
12mm cement parging	0.005
50 mm expanded polystyrene	1.761
200 mm concrete wall	0.092
inside air film	0.120
Total RSI value	**2.008**

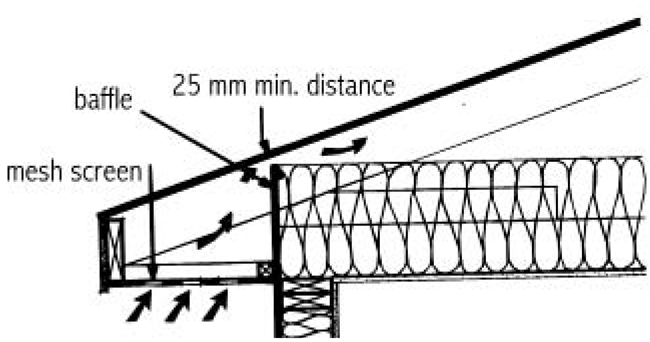


Component	RSI value
outside air film	0.030
12.7 mm gypsum board	0.081
insulation compressed from 70 mm to 64mm	1.338
200 mm concrete wall	0.092
inside air film	0.120
Total RSI value	**1.661**





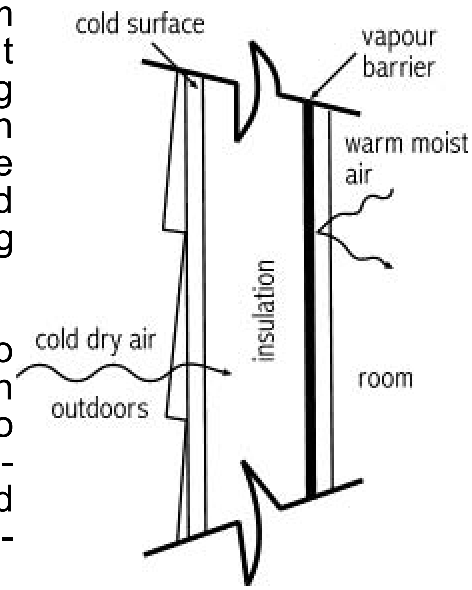




AIR/VAPOUR BARRIER

The air/vapour barrier plays an essential part in insulating homes.

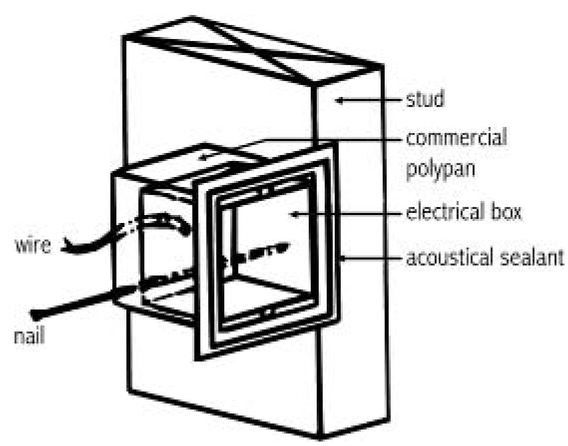
An air/vapour barrier is a moisture-proof film applied to the warm side of insulation to prevent the water vapour in household air from passing through the wall or ceiling and condensing when it reaches the dew point temperature somewhere inside the insulation. Properly installed air/vapour barriers assist greatly in reducing infiltration as well.



Heat loss in homes basically consists of two components: heat loss by conduction through the fabric of the structure, and heat loss due to air exchange within the home in the form of exfiltration of warm air at the top of the structure and infiltration of cold air at the bottom of the structure.

In most newer homes, the amount of heat lost by air exchange is about equal to the amount lost through conduction.

Moisture and air in a home are ultimately tied together. There are two methods by which moisture may exit a structure. One is by pure diffusion through the structure fabric due to vapour pressure differences, and the other is by air loss through the upper end of the structure by moisture laden air. It is this second mechanism that is, in most homes, about 10 times greater than the diffusion loss, and in some fairly leaky structures may be several hundred times greater.



In order to completely control moisture loss from a home to prevent damage to the structure (in the form of moisture condensation in the attic and exterior walls) and to minimize heating costs, the air/vapour barrier must minimize the direct diffusion of moisture into the structure fabric. It must also effectively stop air leakage out of and into the home.

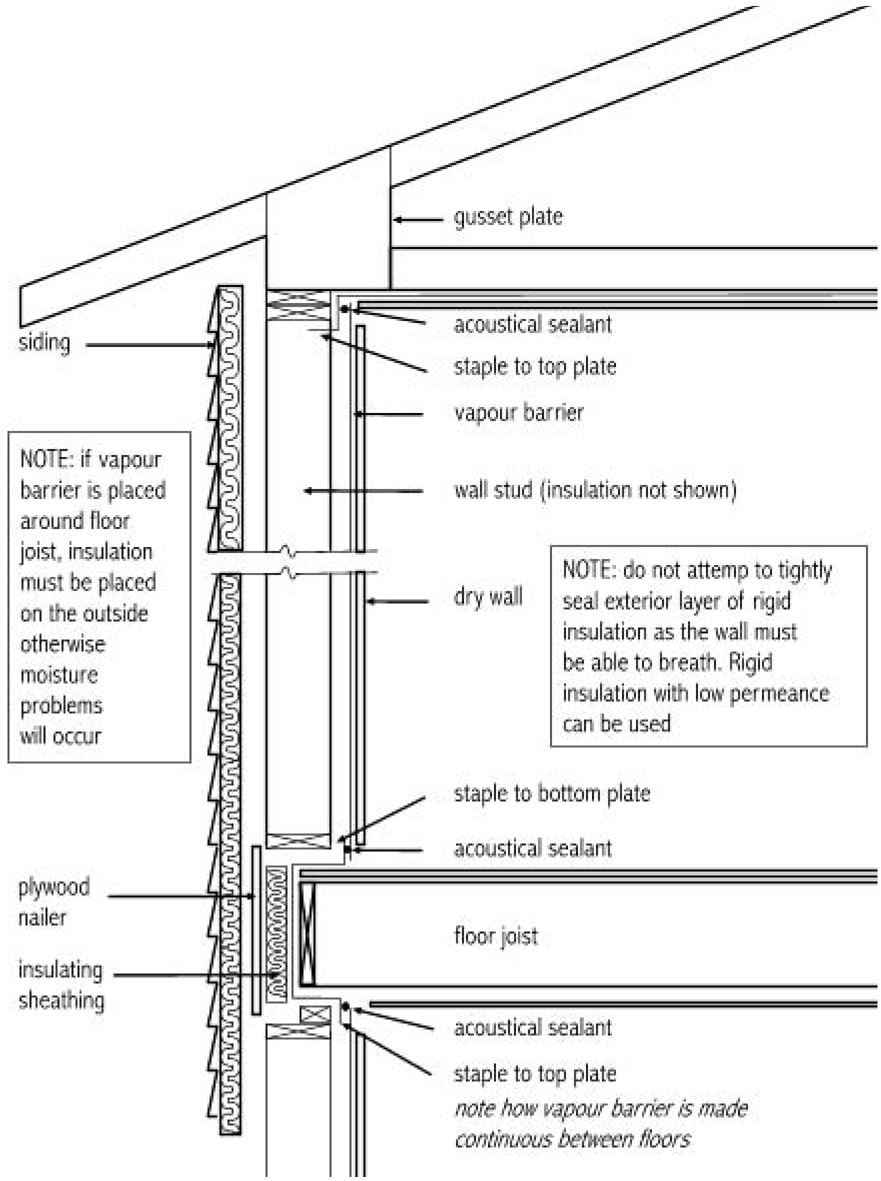
Some common air/vapour barrier materials are:

- polyethylene film
- aluminum foil
- duplex-laminated kraft paper
- varnish or enamel paints.

Generally, the air/vapour barrier should always be on the warm side of any insulated section. The most universally used material is polyethylene film.

Old practices in the use of "vapour barriers" really only control moisture diffusion into the structure and do almost nothing to control air exchange in a home. In order to completely control moisture and air, the air/vapour barrier must be a continuous airtight seal over the entire inner surface of the structure.

To accomplish this, it is important that all joints in the air/vapour barrier be taped or preferably caulked together over a framing member and that airtight seals be applied wherever any services (such as plumbing or electrical) pass through the fabric.



The air leakage points at the top end of the structure are the attic hatch, ceiling light fixture boxes, ceiling fan, rough-in boxes, and cable holes and plumbing vent stack holes in the top plates of interior partitions. The remaining air leakage at the top of a structure is out through the top of doors and windows.

The air that leaves at the top of a house must be replaced by air infiltrating in at the lower end of the house. These air leakage points are the basement or foundation wall itself, the entire joist header section of the upper basement wall, and under the walls sitting on the main floor.

The remaining air leakage is through electrical outlets on exterior walls and around the bottom section of doors and windows. In order to achieve a continuous air/vapour seal in the lower end of the house, especially the joist header sections, it is necessary to use air/vapour proof materials and high quality caulking to provide tight air seals.

EXTERIOR STEPS AND SIDEWALKS

Stairs or steps on the outside of the house can be made of various materials depending on the type of foundation built and what type of steps are desired.

On concrete foundations, precast concrete steps are best suited. They are reasonably inexpensive, very durable and good looking. The steps are set on concrete angle brackets which are bolted right through the foundation. Similar brackets are often used to support pillars and decks instead of using pilings.

In some cases, concrete steps are formed and poured on site. Unless unusual steps are required, this method costs much more than precast and often produces an inferior product. Cast in place steps are also very heavy, requiring careful anchoring to the foundation wall with reinforcement to prevent settling and cracking of the step.

With wood foundations four different systems may be used. The step may be precast concrete, prefabricated fibreglass, wood or wood on a metal framework.

Precast concrete steps are not always suitable as these steps are too heavy to be hung on the wood foundation wall. Precast concrete can be used if set on four pilings, but the pilings must be properly constructed to avoid settling problems. Pilings need to be approximately 8 feet in depth, with a reinforcing rod down the center. An alternative is to set the back of the step on a shorter preserved wood wall just outside the actual preserved wood foundation called a knee wall.

Prefabricated fibreglass steps are light enough to be attached to the wood foundation wall and supported on the front by angle braces of preserved wood resting against the bottom portion of the foundation wall. The biggest drawback to fibreglass steps is their high cost.

Wood steps are attached to the foundation and supported the same way as the fibreglass steps. Since this wood will be open to the weather and any wood framework under the steps may be subject to rotting, pressure treated lumber should be used. This type of step construction is fairly inexpensive. To control the wear on wood treads a very tough finish should be applied to the traffic areas (fibreglass with an anti-slip material on the surface - sand, etc. - or one of the asphalt rubber surfaces available as deck coating).

Wood steps on a metal framework is the method most often used for wood foundations. A welding shop will fabricate a frame to accommodate wood treads and landings. This framework is bolted to the foundation wall and supported at the front on pilings or angled preserved wood reaching back to the bottom of the foundation wall. Again, care must be taken to properly finish the wood surface to prevent wear.

Most sidewalks are made of concrete - either poured in place or precast. Precast blocks are the cheapest and most convenient sidewalk system. As the soil around the house settles and shifts during the first few years after construction, the blocks can be lifted and re-levelled .

Cast in place concrete walks undoubtedly look the best, but are fairly expensive. You should consider postponing the pouring of sidewalks until the soil around the house has finished settling - usually after two years. Consider starting off with sidewalk blocks, then sell them (they retain their value well) when you pour your walks.

Another option is concrete bricks - either plain or interlocking - laid in a bed of sand. Similar to blocks, the bricks offer the advantage of being lifted and re-levelled if settling does occur. These walk systems are very expensive to install but are very attractive and should last the life of the house.

In areas where cost in place concrete is prohibitively expensive and transportation costs for precast concrete blocks and interlocking bricks is high, Preserved Wood Foundation is a good alternative. Care should be taken to allow free movement of air beneath the sidewalk, with no low spots for water to accumulate in. Done properly, wooden walks can be a landscaping feature.