TABLE OF CONTENTS

INTRODUCTION

The building interior is looked at for a number of reasons. The interior provides clues to structural problems and is often the area where water leakage is first detectable. The interior finishes themselves usually reflect the overall building quality and their condition helps indicate the level of overall maintenance.

The house interior contains the distribution points of the major systems. For example, each room should have an adequate heat supply and sufficient electrical outlets. The concern of the home inspector is function rather than appearance, and emphasis is placed on whether the room will work as it was intended. The home inspector does not comment on matters of personal taste.

1.0 MAJOR FLOOR FINISHES

Floors provide a durable surface for foot traffic and furniture. Good floors are level, have an even surface, and stand up for many years with little maintenance. Floors can be an architectural feature of the home. Different flooring materials have different properties. Some resist water damage; some are soft to walk on; some require no sealing or waxing; some are quiet; some are particularly long lasting.

Water Damage: Water damage is one of the most common problems on interior finishes. The water damage may be on walls, floors or ceilings. There are five areas of interest, typically, with any evidence of water damage. It is helpful to know a) the source of the damage, b) whether it is still active, c) whether there is any concealed damage, d) what the cost is to cure the problem, e) and subsequently, what the cost is to repair the damaged building materials.

Common sources of water damage include roof leaks, flashing leaks, ice damming, window and skylight leaks, plumbing leaks, leaks from hot water heating systems, and condensation. Water damage may also result from such things as aquariums, room humidifiers or dehumidifiers, over-watering of plants, melting snow and ice from boots during wintertime, etc.

Roof leaks are usually localized and the source of the problem will often be an intersection or a flashing in the roof. Roof leaks can be difficult to trace because the water does not always appear on the interior immediately below the leak above. This may be the result of water running along framing members, or vapor barriers which prevent water coming through in specific locations. Many roof leaks appear first around ceiling tight fixtures, for example.

Water damage often looks more serious than it is. Short term exposure to water will not harm most building structure materials. Plaster and drywall, however, are damaged very quickly by water. Similarly, many floor finishes can be damaged or stained quickly by water. In one sense, this is good. The material which can be easily seen is the first material to deteriorate. It is unusual to have extensive building damage done by water which appears at an interior finish, as long as the problem is solved promptly.

1.1 Concrete: Concrete floor finishes are typically only used in basements and garages. In new construction, the concrete basement floor is at least three inches thick. The floor should slope down to a floor drain. The slope is dramatic in some cases and barely perceptible in others.

In modern construction, a four to six inch gravel base is provided below the slab to minimize water moving up through the slab. The gravel allows water to drain away freely, rather than holding water against the slab. Moisture barriers (plastic sheets) may also be provided under the slab, and in energy efficient construction, or slab-on-grade construction, rigid insulation is sometimes used below the floor.

In older construction, concrete floor slabs were as thin as 1/2 inch. Very often these were not underlaid with a gravel base, and are prone to impact damage, heaving and break-up.

It is important to understand that concrete floors are not part of the structure. They are typically installed after the structure is up, although, ideally before finish flooring or millwork is done. A good deal of moisture is given off as concrete cures, and the basement should allow good air movement to dissipate this moisture.

Concrete floors can be overlaid with finished flooring, as desired. However, since almost every house has water on the basement floor sometime during its life, the choice of finishes should anticipate this.

Cracked or Broken

Problems: A cracked and broken concrete floor may only be a problem if it is not safe to walk across, or if there is moisture coming up through the floor. Since it is not a structural component, replacement of this floor is rarely a priority item.

The solution is to remove the broken flooring and provide a new floor. Ideally, a four to six inch gravel base should be provided before the new three inch thick concrete slab is poured. Often, this will reduce basement ceiling height to an unacceptable level. Eliminating the gravel base, or reducing its thickness, and reducing the thickness of the concrete will slightly increase the risk of future break up or water problems.

Poor Slope

A concrete floor which does not slope down to a floor drain can lead to water accumulation on the floor if there is significant leakage, either from outside water or from plumbing or heating water. Adding more concrete to an existing slab is difficult, since the chances of the new concrete bonding to the old are very slim. A better solution is probably to add another floor drain. This is expensive in that it does require breaking up some of the concrete floor. If the concrete floor is deteriorated overall, it may make sense to remove the entire floor and replace it.

Cold

If the basement is to be used as living space, the concrete floor is often cold. One solution is to place a raised wood floor over the concrete prior to adding a finish flooring material. Disadvantages to this approach include the expense, the loss of headroom and the fact that rot and/or termite activity may go undetected for some time. In most cases, a comfortable situation can be created with an underpad and carpet. Both should be synthetic and as moisture resistant as practical. Where the floor slab is to be replaced, the underside of the floor slab can be insulated with a material designed for this application.

1.2 Hardwood: Hardwood floors are typically oak, although other woods such as birch, beech and maple, are also used. Hardwood flooring may be in the form of strips, typically tongue-and-groove, or parquet. Parquet floors often consist of six inch squares with each square made up of six one-inch strips. The squares are laid with the grain in adjoining squares at right angles, giving a checkerboard effect to the floor. Parquet flooring may be nailed or glued down. There are several different types and installation techniques.

Hardwood flooring in modern construction is typically 3/8 inch or 3/4 inch thick and may be pre-finished or finished on site.

In some cases, hardwood flooring was used without any subflooring. This is an acceptable approach as long as the hardwood is 1/2 inch thick or more. The width of the hardwood strips varies, but is typically 1-1/2 inches to 2-1/2 inches. Hardwood flooring boards wider than three inches are called planks.

The hardwood flooring should not be laid parallel to board subflooring. If the subflooring is installed on the diagonal, the hardwood flooring can be installed in either orientation (45' offset from the subfloor). If the subflooring is perpendicular to the joists, the hardwood flooring should be parallel to the joists.

With tongue-and-groove flooring, the underside is usually slightly hollowed, and the top edge of the board is slightly wider than the lower edge. The idea is that the top edges of the board should fit snugly and there can be a small gap at the bottom edge. A gap at the top would be undesirable, of course. The hardwood strips are nailed in place by toe-nailing through the tongue. Nails are driven in at a 45º angle. When the floor is finished, no nails should be visible.

Problems: Hardwood flooring is a high quality and durable floor system. It can be mechanically damaged, attacked by termites, rot and fire, or damaged by water. Wood flooring is not ideally suited to kitchen and bathroom areas, since it is susceptible to water damage. It is possible to replace individual boards that are damaged, but matching can be tricky.

The 3/8 inch thick hardwood flooring can usually be sanded once to provide a new wood surface. 3/4 inch hardwood flooring can be sanded several times. Wood flooring can be covered with carpeting or other flooring materials.

Hardwood flooring glued to concrete often comes loose. The glue is broken down by water in the floor, and pieces of flooring pop out. After the floor is dried, the floor can be reattached. If the wood is warped or water stained, it should be replaced.

Squeaky Floors: Squeaky floors are not a structural problem. A floor usually squeaks when walked on because the flooring finish or subfloor is not tightly secured to the floor joists below. The subfloor sitting directly on the joists must be secured tightly to the joists, and the finished flooring material (e.g. hardwood) must similarly be tightly fastened to the subfloor. This is done with nails, screws and/or glue.

When the flooring is not tightly secured, it sits just off the support in some spots. When someone steps on the flooring in this area, it is pushed down onto its support. When the foot is taken off the floor, it springs back up. The squeaking is usually the result of the nails sliding in and out of the nail holes, or adjacent wood surfaces rubbing.

Resecure

The solution, of course, is to better secure the hardwood to the subfloor, or the subfloor to the joists. This can be done with nails or screws. It is difficult to glue a floor down after it has been installed. It can be very difficult to get at the floor system. Sometimes the finish flooring material is removed, or the floor is resecured from below (if the ceiling below is unfinished).

When nailing or screwing a subfloor to the joists from above, it is sometimes difficult to find the joists. Nails or screws which do not enter the joists are of no value. Wood shims or blocking are sometimes used from below.

Talcum Powder

Surface nailing into hardwood flooring is not desirable from a cosmetic stand point, and where the floor system cannot be pulled down tightly from below, a dry lubricant such as talcum powder is sometimes used. The lubricant is spread onto the floor and worked into the cracks. If enough of the lubricant reaches the nails, the squeaking noise may be eliminated as the nails slide in and out of the holes. While this method will often result in some improvement, it is rarely completely effective in eliminating squeaks.

1.3 Softwood: Pine is the most common softwood flooring. Pine floors were typically used either as finish flooring in a “1x4” tongue-and-groove configuration, or as a subfloor. When used as a subfloor below hardwood, the softwood was typically laid in 1x4 or 1x6 planks, perpendicular to, or on the diagonal to the floor joists. In this case, the subflooring was nailed straight down into the joists. The boards were typically separated slightly to allow for expansion.

Softwood subflooring used under linoleum or other thin kitchen floor coverings was usually tongue-and-groove and tightly fit to provide a smooth, strong surface upon which to put the flexible flooring system. Modern practice is to use 1/4 inch plywood underlayment between the subfloor and finish flooring.

Damage

Problems: When softwoods such as pine, fir or cedar are used as finish floorings, they present a relatively soft surface which can be damaged by high heeled shoes, for example. Furniture marking and denting is another common problem on softwood floors.

Sanding

It is more difficult to sand softwood floors than hardwood, because low spots can be created very quickly by the sanding machine. Generally speaking, a softwood floor can only be satisfactorily sanded once. Because this material has no subfloor below, it cannot be safely sanded to less than roughly 5/8 inch thick. It should be noted that with a tongue-and-groove flooring system, the sanding limitation is not working right through the floor, but working down through the floor far enough to expose the tongue or weaken the groove between the boards.

It has become popular to expose pine subflooring in kitchens. While the honey color of pine is considered very attractive, it should be understood that this is not an ideal kitchen floor system. Apart from being relatively soft, it is very difficult to keep the joints well sealed, and liquid spills are difficult to clean up completely. Polyurethane finishes commonly used do not, over the long term, provide a watertight membrane. It is common, when softwood floors are sanded, to mix the sawdust which is generated with a glue, and work the mix into the open joints to provide a filler material. This filler material can work loose and pop out of the floor.

Softwood floors can be damaged by rot, termites and fire.

Squeaky Floors:

Squeaky floors are not a structural problem. A floor usually squeaks when walked on because the floor is not tightly secured to the floor joists below.

When the flooring is not tightly secured, it sits just off the support in some spots. When someone steps on the flooring in this area, it is pushed down onto its support. When the foot is taken off the floor, it springs back up. The squeaking is usually the result of the nails sliding in and out of the nail holes, or adjacent wood surfaces rubbing.

The solution, of course, is to better secure the floor to the joists. This can be done with nails or screws. It is difficult to glue a floor down after it has been installed. Sometimes the floor is resecured from below (if the ceiling below is unfinished).

When nailing or screwing a floor to the joists from above, it is sometimes difficult to find the joists. Nails or screws which do not enter the joists are of no value. Wood shims or blocks are sometimes used from below.

Surface nailing into flooring is not desirable from a cosmetic standpoint, and where the floor system cannot be pulled down tightly from below, a dry lubricant such as talcum powder is sometimes used. The lubricant is spread onto the floor and worked into the cracks. If enough of the lubricant reaches the nails, the squeaking noise may be eliminated as the nails slide in and out of the holes. While this method will often result in some improvement, it is rarely completely effective in eliminating squeaks.

1.4 Wool Carpet: Wool is an expensive carpeting material favored for its look, feel and durability. As synthetic products have improved and remain less expensive, wool is becoming rare as a broadloom carpet material. It is used in many carpets, blended with a synthetic material. Wool is a natural product and is less resistant to water damage than synthetics. It also has less resistance to stains than some synthetics.

Problems: Even the best quality carpet will eventually wear out in high traffic areas first. Carpet which is stained can sometimes be cleaned or dyed, although this is often not completely successful. Carpet which stretches and develops ridges and buckles can be pulled tight to lie flat again by a carpet installer.

Carpet installed in an area which is chronically damp (e.g. some basements) will eventually rot. Carpeting is not an ideal flooring material in kitchen and bathroom areas, since it is difficult to clean up spills. Wool carpet is susceptible to burns, as is synthetic carpet.

Squeaky Floors: Squeaky floors are not a structural problem. A floor usually squeaks when walked on because the hardwood or subfloor below the carpet is not tightly secured. The subfloor sitting directly on the joists must be secured tightly to the joists. This is done with nails, screws and/or glue.

When the flooring below the carpet is not tightly secured, it sits just off the support in some spots. When someone steps on the flooring in this area, it is pushed down onto its support. When the foot is taken off the floor, it springs back up. The squeaking is usually the result of the nails sliding in and out of the nail holes, or adjacent wood surfaces rubbing.

The solution, of course, is to better secure the hardwood (if any) to the subfloor and the subfloor to the joists. This can be done with nails or screws. It is difficult to glue a floor down after it has been installed. Sometimes the floor is resecured from below (if the ceiling below is unfinished). In some cases, it is possible to nail through the carpet to secure the flooring. Nails with very small heads are used.

When nailing or screwing a subfloor to the joists from above, it is sometimes difficult to find the joists. Nails or screws which do not enter the joists are of no value. Wood shims or blocks are sometimes used from below.

1.5 Synthetic Carpet: Synthetic carpeting is the most common and is recommended in areas where the carpeting may become wet. Where the backing material is not moisture resistant, synthetic carpet will be quickly damaged if wet. Jute backed carpets, for example, should be kept dry. Many types can be cleaned more easily than wool. Common materials include polypropylene, nylon and acrylic. The quality of a carpeted floor depends upon the type, weight and construction of carpeting, the type of underpad, and the installation work.

Synthetic carpet will wear out and may be stained. Some stains can be removed with cleaning materials or dyes, although the results are not always satisfactory. Although synthetic carpets are better than wool in damp environments, if enough moisture is present, mold and mildew will become problems and the carpet will deteriorate.

Synthetic carpeting in kitchens and bathrooms is better than wool, but is still very difficult to clean. In general, this is not a recommended floor finish in these areas. Indoor/outdoor carpeting is more resistant to moisture than conventional carpets, although in kitchens and bathrooms it may hold the stains, spills and odors.

If the carpeting develops ridges or buckles, it can be pulled tight by a carpet installer. Poor seams can usually be improved by a good installer. Most carpeting has a grain and adjacent pieces of carpeting should be installed with the grain oriented the same way. Synthetic carpeting is susceptible to burns.

Squeaky Floors: Squeaky floors are not a structural problem. A floor usually squeaks when walked on because the hardwood (if any) or the subfloor is not tightly secured. The subfloor sitting directly on joists must be secured tightly to the joists. This is done with nails, screws and/or glue.

When the flooring is not tightly secured, it sits just off the support in some spots. When someone steps on the flooring in this area, it is pushed down onto its support. When the foot is taken off the floor, it springs back up. The squeaking is usually the result of the nails sliding in and out of the nail holes, or adjacent wood surfaces rubbing.

The solution, of course, is to better secure the hardwood (if any) to the subfloor and the subfloor to the joists. This can be done with nails or screws. It is difficult to glue a floor down after it has been installed. It can be very difficult to get at the floor. Sometimes the floor is resecured from below (if the ceiling below is unfinished). In some cases, it is possible to nail through the carpet to secure the flooring. Nails with very small heads are used.

When nailing or screwing a subfloor to the joists from above, it is sometimes difficult to find the joists. Nails or screws which do not enter the joists are of no value. Wood shims or blocks are sometimes used from below.

1.6 Resilient: Resilient floor coverings include vinyl-asbestos, solid vinyl, vinyl faced, rubber, cork, asphalt and linoleum, installed in sheets or tiles. The material is glued down. Some of these materials are inexpensive, while others are very costly, especially if the product includes a cushioned backing material and a no-wax surface.

In modern construction, these materials are typically applied over an underlayment such as a 1/4 inch plywood. Since most of these materials are very thin, they will show through any irregularities in the floor surface.

Some of the modern tile systems employ a peel-and-stick adhesive. A paper backing is removed to expose the adhesive as the tile is laid.

Problems: Where flooring is improperly installed, lifting or loose sections can be a problem. Most resilient floorings are susceptible to cutting and burning. Localized repairs are very difficult to make. Flooring laid over uneven surfaces may not stay fastened, will show the irregularities and will usually fail prematurely.

Some of the backing material on tiles or sheet goods is quite susceptible to moisture. Where the back of a flooring is likely to be wet, even intermittently, these materials should not be used. Floor replacement may be necessary where this has been done, particularly with tile floors, since the number of seams makes it fairly easy for water to get through. Some of the materials are vulnerable to color change if exposed to direct sunlight over time. While this does not affect the usability, appearance is usually an issue.

Squeaky Floors: Squeaky floors are not a structural problem. A floor usually squeaks when walked on because the subfloor is not tightly secured to the floor joists below. Resecuring is done with nails, screws and/or glue. It is also possible for the underlayment to be poorly secured to the subfloor.

When the flooring or underlayment is not tightly secured, it sits just off the support in some spots. When someone steps on the flooring in this area, it is pushed down onto its support. When the foot is taken off the floor, it springs back up. The squeaking is usually the result of the nails sliding in and out of the nail holes, or adjacent wood surfaces rubbing.

The solution, of course, is to better secure underlayment to the subfloor or the subfloor to the joists. This can be done with nails or screws. It is difficult to glue a floor down after it has been installed. It can be very difficult to get at the floor. Sometimes the finish flooring material has to be removed, or the floor is resecured from below (if the ceiling below is unfinished).

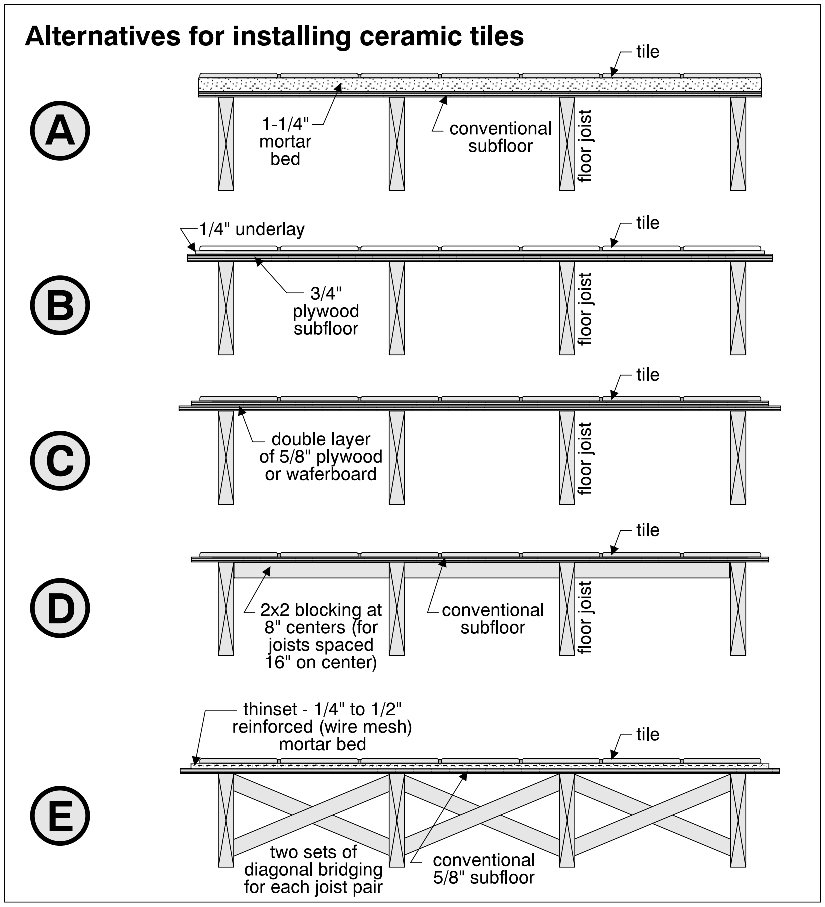
When nailing or screwing a subfloor to the joists from above, it is sometimes difficult to find the joists. Nails or screws which do not enter the joists are of no value. Surface nailing into resilient flooring is not acceptable. Wood shims or blocking are sometimes used from below.

1.7 Ceramic/Quarry Tile: Generally considered to be high quality materials, ceramic or quarry tiles are hard fired clay products which may be glazed or unglazed. These materials stand up well to heat, water and normal wear and tear, and have good resistance to stains and cuts. These are brittle floor systems, subject to cracking if not well supported. A conventional wood flooring system generally has too much flex to permit ceramic or quarry tile. Better installations include a concrete base for the tile, typically one inch to five inches thick. Ideally, the tiles are pressed into the concrete while it is still setting. Joints are then grouted. Tiles are typically 1/4 inch to 1/2 inch thick and may be any size from one inch by one inch to twelve inches by twelve inches. Several shapes, colors, patterns and finishes are available.

In modern construction, a very thin mortar base or adhesive is used over a thicker subfloor than would ordinarily have been used. If well installed, this can be satisfactory. Again, joints have to be appropriately grouted. It is common for ceramic or quarry tile floors to be cracked in areas where floor joists are susceptible to the most deflection, or where heavy traffic patterns occur. Tiles can be damaged by dropping tools or other heavy objects.

Traditionally, ceramic tile floors were used in bathrooms and vestibules, because of their natural resistance to moisture. Ceramic or quarry tile floors are used in kitchens, for the same reason, although they are unforgiving if one drops glass onto them, and they are also somewhat more tiring to stand on because of their very hard surface.

Current building codes generally require that ceramic tile be set in at least 1-1/4 inches of mortar, (when mortar is used) and that a 2x2 inch galvanized wire mesh be used in the mortar bed. If laid on a wood subfloor, sheathing paper or another suitable water resistant material should be laid on top of the wood subfloor before the mortar is added.



If the tiles are adhered to a conventional wood subflooring, one of the following reinforcement techniques should be used:

1. Subflooring should be at least 3/4 inch plywood or waferboard with the edges supported by two by two’s. The joists should be on sixteen inch centers, maximum. A 1/4 inch plywood underlay should also be used.

2. A 5/8 inch underlay should be provided over the subfloor. The seams of the underlay should be staggered, relative to seams in the subfloor.

3. Two by two blocking can be used under the subfloor, running perpendicular to the joists. The blocking should be spaced no more than eight inches apart for floor joists sixteen inches on center.

Problems: The most common problem with these floor tiles is cracking. This is usually the result of a floor system which is not stiff enough to support the tile. The solution, of course, is to improve the floor rigidity. Tiles can also be cracked by impact damage. Heavy items dropped on the tiles will sometimes crack or break them. Replacing individual tiles is not difficult, although color change and grout matching may be a problem.

Occasionally, incorrect grouts are used, the grout is improperly mixed, the grout is poorly installed, or grouts deteriorate due to unusual conditions. Regrouting is not terribly difficult, although matching colors can be a problem.

Some ceramic tiles are intended for wall use only. When used on floors, they will deteriorate quickly. They should, of course, be replaced with an appropriate tile.

1.8 Slate/Stone/Marble/Terrazzo: Slate, stone and marble are naturally occurring materials which are cut to size for use as flooring tiles. Terrazzo is made up of marble chips set in concrete, usually laid in squares defined by lead beading. The surface is polished to give a smooth floor. This high quality flooring is common in hospitals and schools, for example.

These materials are not terribly common residentially, although they are used in some high quality houses. In terms of their strength, appearance and durability, they are among the best available. Installation techniques have to be similar to ceramic and quarry tile, in that the weight of the material itself may cause deflection of conventional flooring systems. Joints on slate, stone, and marble must be properly grouted.

Problems: Cracked or broken flooring is the most common problem with these materials. The source of difficulties is usually a floor system with too much flex for this type of surface. The solution is, of course, to reinforce the floor and replace the damaged pieces. Improper grout mix or installation can lead to problems. Regrouting is time consuming, but not terribly difficult. Grouting does not apply to terrazzo floors.

Marble and some stone floors are susceptible to staining.

1.9 Laminate: In recent years, laminate flooring has become very popular, especially among do-it-yourselfers. Laminate floor planks (or tiles) have several layers. The top layer is generally a clear laminate that is bonded to a decorative layer, which most often gives the planks the look of a wood floor. These layers are bonded to a wood- or fiber-based core. The bottom layer may be a paper or melamine backing. A complete floor is created by either snapping planks together using specially-designed tongue and groove fasteners along the edges, or by gluing planks together along traditional tongue and groove edges.

Laminate flooring is not secured to the subfloor beneath it. Instead, it is installed as a floating floor, allowing it to expand and contract. A sheet of cushioning foam is installed between the laminate flooring and the subfloor. There may also be a sheet of plastic below the foam to act as a moisture barrier and to allow the floor to slide as it expands. A gap is required between the flooring and the wall to allow for expansion, although this is covered by trim.

Laminate flooring is not designed to be sanded, stained, or otherwise refinished, although individual planks may be replaced if damaged.

Laminate flooring is resistant to small amounts of water, such as quickly wiped-up spills, but special precautions must be taken when installing it in kitchens or bathrooms, including applying a sealant around the perimeter. This is not visible during the course of a home inspection. It is not recommended that laminate flooring be installed in damp basement areas.

► 2.0 MAJOR WALL FINISHES

Wall finishes provide a decorative skin to conceal building components. Wall finishes hide structural members, insulation, ductwork, pipes, and wires. Good wall finishes are plumb and straight. Surfaces may be smooth or textured and better wall finishes are durable. Some wall finishes are versatile, taking decorative finishes such as stain, paint or wallpaper readily. Walls may make a decorating statement, or may be simply background. In some cases, the combustibility of wall finishes may be of interest. In kitchens and bathrooms, resistance to water damage is an asset.

Water Damage: Water damage is one of the most common problems on interior finishes. The water damage may be on walls, floors or ceilings. There are five areas of interest, typically, with any evidence of water damage. It is helpful to know a) the source of the damage, b) whether it is still active, c) whether there is any concealed damage, d) what the cost is to cure the problem, e) and subsequently what the cost is to repair the damaged building materials.

Common sources of water damage include roof leaks, flashing leaks, ice damming, window and skylight leaks, plumbing leaks, leaks from hot water heating systems, and condensation. Water damage may also result from such things as aquariums, room humidifiers or dehumidifiers, over-watering of plants, melting snow and ice from boots during wintertime, et cetera.

Roof leaks are usually localized and the source of the problem will often be an intersection or a flashing in the roof. Roof leaks can be difficult to trace because the water does not always appear on the interior immediately below the leak above. This may be the result of water running along framing members, or vapor barriers which prevent water coming through in specific locations. Many roof leaks appear first around ceiling light fixtures, for example.

Water damage often looks more serious than it is. Short term exposure to water will not harm most building materials. Plaster and drywall, however, are damaged very quickly by water. The material which can be easily seen is the first material to deteriorate. It is unusual to have extensive building damage done by water which appears at an interior finish, as long as the problem is solved promptly.

2.1 Plaster/Drywall: Plaster and drywall are essentially the same material. Drywall is premanufactured while plaster is mixed and applied by trowel on site. Plaster and drywall are made largely of gypsum. In some cases, aggregate or fibers are added to the gypsum as stabilizers and strengtheners. Horse hair was one of the materials commonly added to older plaster to help strengthen it. Lime may be added to improve workability.

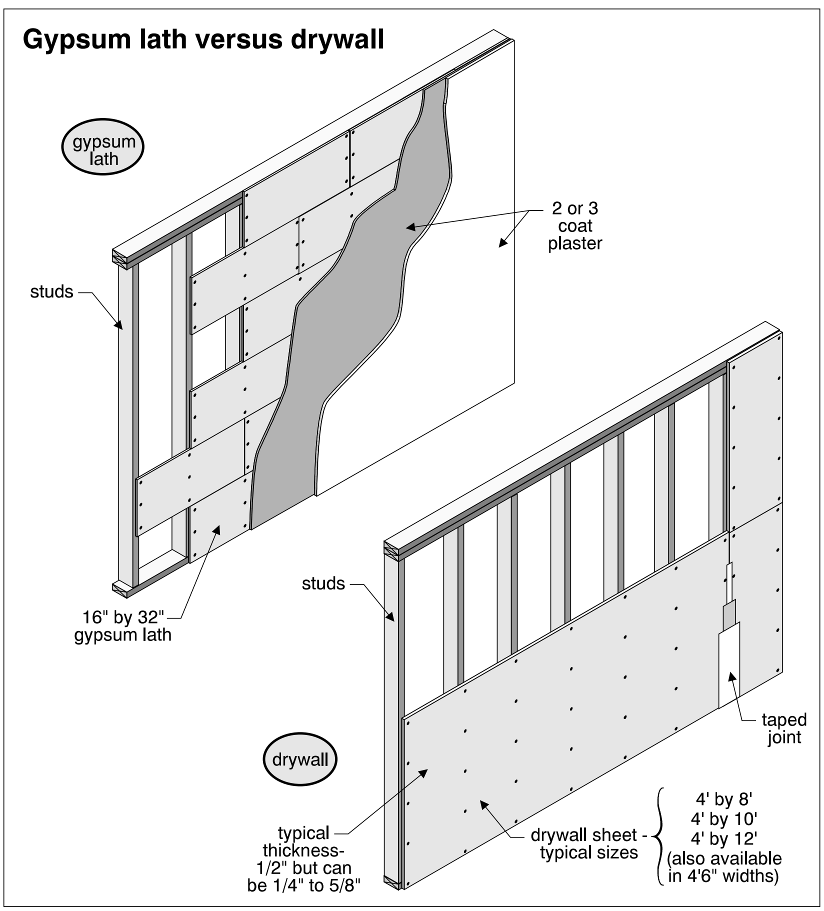
These interior finishes are very common because they are inexpensive, relatively easy to apply and afford good fire resistance.

Wood Lath

Older plaster systems typically employ a wood lath which is comprised of boards roughly one inch wide by one-quarter inch thick. These "yardstick" type boards were nailed to the studs or strapping horizontally, with roughly one-quarter inch spaces between each board. The plaster was then trowelled on in two or three coats. The first layer of plaster would ooze through the spaces between the wood lath, sag, and harden to form a "key" which held the plaster onto the lath. This first layer is called a "scratch" coat. Where a three step process is used, the second coat is called the "brown" coat and the third is a "finish or putty" coat, In a two step process, there is still a scratch coat and a brown coat, but they are applied one immediately after the other. The finish coat is applied after the brown coat has set.

Gypsum Lath

In the late 1930's, gypsum lath became popular. These premanufactured plaster sheets replaced the wood lath because they were quicker and less expensive to install. The gypsum lath was paper covered, similar to drywall. It came in various sizes, but was typically sixteen inches by forty-eight inches. The gypsum lath was covered with one or two coats of plaster and the total thickness of the system would be approximately 1/2 to 5/8 inch. The lath itself is typically 3/8 inch thick.

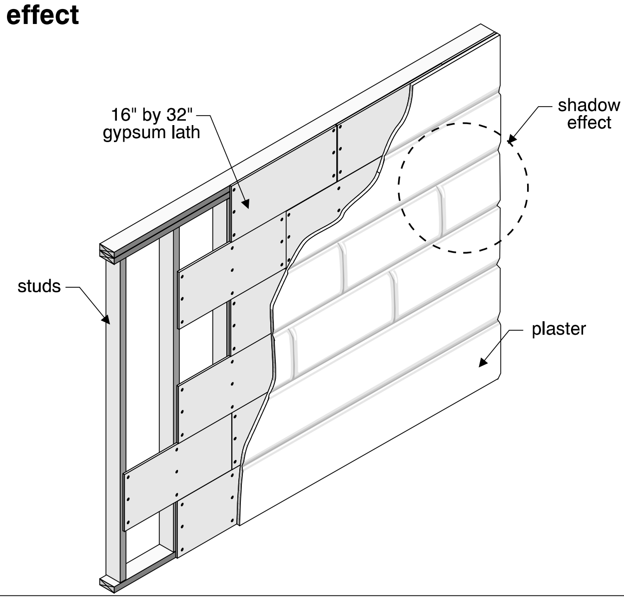


Wire Lath Wire mesh lath is sometimes used in areas where reinforcing is necessary, for example, on door frames and comers. Wire lath was also used in some bathroom areas in some cases where ceramic tile was to be provided.

Drywall Drywall became popular in the early 1960's, and is used almost exclusively today. There is very little difference between properly executed drywall and plaster jobs. Poor drywall work is usually identified at the seams. Sections of drywall are typically four feet by eight, ten, twelve, or fourteen feet. Drywall is typically available in 3/8 inch, 1/2 inch and 5/8 inch thicknesses.

The seams between boards must be taped and filled with drywall compound. If the taping and finishing work is poor, the seams can often readily be seen. Special drywalls, resistant to water or fire are available.

Shadow effect

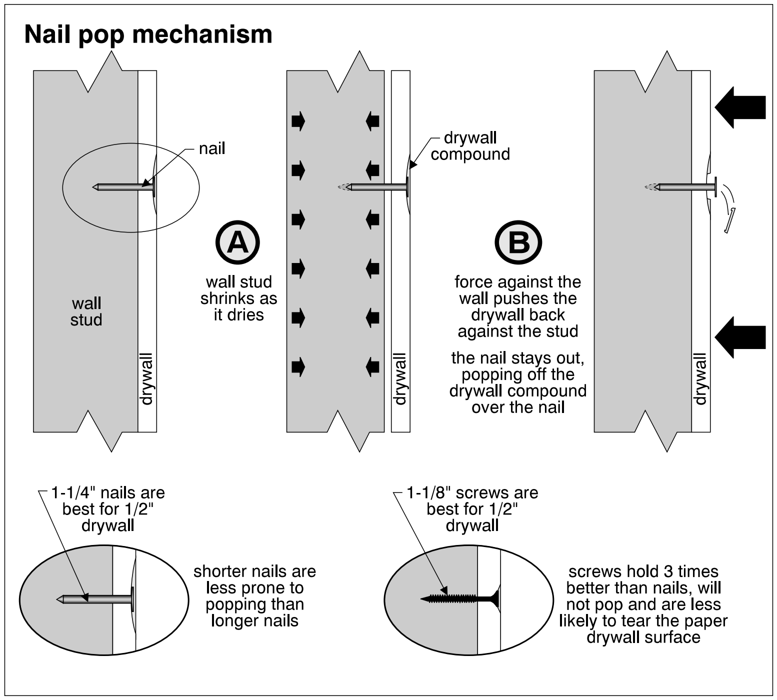


Damage Problems: Both plaster and drywall can be readily patched where small damaged areas are noted. Re-drywalling over old plaster or drywall is sometimes done where large areas are damaged.

Shadow Effect A common problem with plaster applied over gypsum lath is the shadow or bulge effect. This was created when the plaster was applied too quickly. The finish coat was sometimes applied before the first coat dried completely. The moisture was driven back into the gypsum lath which sagged. The result is a pattern visible in the wall or ceiling that shows seams every sixteen inches in one direction. Sometimes seams are also visible perpendicular to these, at thirty-two or forty-eight inch intervals. This pattern is often only visible with a bright light shining across the plaster surface.

The problem is not progressive. No repairs are necessary. If improved appearance is desired, a skim coat of plaster can be added, depending on the condition of the surface. A plasterer should be consulted.

Loose Where plaster has lost many of it keys, due to the vibration and wear and tear of everyday living, large sections of walls or ceilings may become loose. Where there is danger of plaster falling, this should be corrected promptly. People can be seriously hurt by falling plaster.



Solutions Removal of the old plaster, and replacement with new plaster or drywall is the preferred approach. However, removing old plaster and lath is messy, disruptive, and time consuming. Adding new drywall over old plaster is common and may be acceptable. It is critical to attach the drywall through the old plaster to the studs or strapping. Attaching the drywall to the plaster alone may only accelerate the plaster coming off. Adding new plaster or drywall over walls and ceilings may result in baseboards, trim and decorative moldings looking recessed into the wall. This may or may not be acceptable cosmetically. Electrical boxes also sink back into the wall when drywall is added over plaster.

Another option is to replaster over old plaster. This is often accomplished by fastening wire lath over the old plaster and then applying plaster in the common two or three step process.

Applying a new finish over loose cracked plaster may accelerate the deterioration, due to the added weight.

2.2 Paneling: Paneling may take the form of veneered plywood, asbestos-cement board, veneered particle board, or solid wood. It is available in many forms and appearances, varying from a simple and inexpensive 1/8 inch sheet of 4 x 8 plywood, to an intricate, highly finished hardwood system, typical of dining rooms and libraries in high quality homes.

Problems: Paneling is often more durable than a plaster or drywall finish, although wood materials, of course, undergo more movement as a result of expansion and contraction. These finishes can be considerably more expensive than drywall. In some applications, the combustibility of this material may be an issue. Most paneling does not take paint or wallpaper as readily as drywall or plaster. Redecorating paneling can be difficult without removing it. Some paneling is difficult to patch without leaving any evidence.

2.3 Brick/Stone: These are not common wall finishes, and may be unfinished walls in many cases. However, some renovation work includes removal of original plaster to expose brick construction on either interior or exterior walls. This brickwork was usually not intended to be viewed, and may show a large number of small, damaged or off-colored bricks. Mortar joints are often quite irregular.

Removing plaster from an exterior brick wall reduces the insulating value of the wall, and can make the room colder. Removing plaster from an interior brick wall does not pose the same problem, although it does reduce the acoustic insulating properties of the wall. This may be an issue, for example, on a semidetached house with a common brick wall. Sealing exposed brick walls helps control the dust from the bricks and mortar.

Thin slices of brick approximately one-half inch thick, or imitation brick can be applied to a wall using an adhesive or embedding the brick in mortar. This is sometimes done around fireplace openings to create the illusion of a solid masonry fireplace. Full bricks are not used because the weight involved would require resupporting the floor below.

2.4 Concrete/Concrete Block: These materials are associated with unfinished walls, typically in a basement. They can be painted to provide a more finished appearance. Concrete is strong and these walls are unlikely to be damaged as a result of normal usage. Waterproofing products are often applied to the interior faces of basement concrete or block walls in an effort to reduce moisture penetration. This is rarely completely effective.

2.5 Stucco/Textured/Stipple: Interior stucco is essentially plaster, and is typically installed in a two or three coat process. The finish is often sculpted or worked to provide a decorative appearance. The texturing is done with trowels, sponges, brushes, or other tools to give the desired effect. In modern construction, a sprayed on one-coat stipple finish is often used over drywall.

Problems: The modern stipple finish is inexpensive and quick to apply. It does not, however, cover poor drywall work, as flaws will show through. It should also not be used in kitchen or bathroom areas since the uneven surface is very difficult to clean.

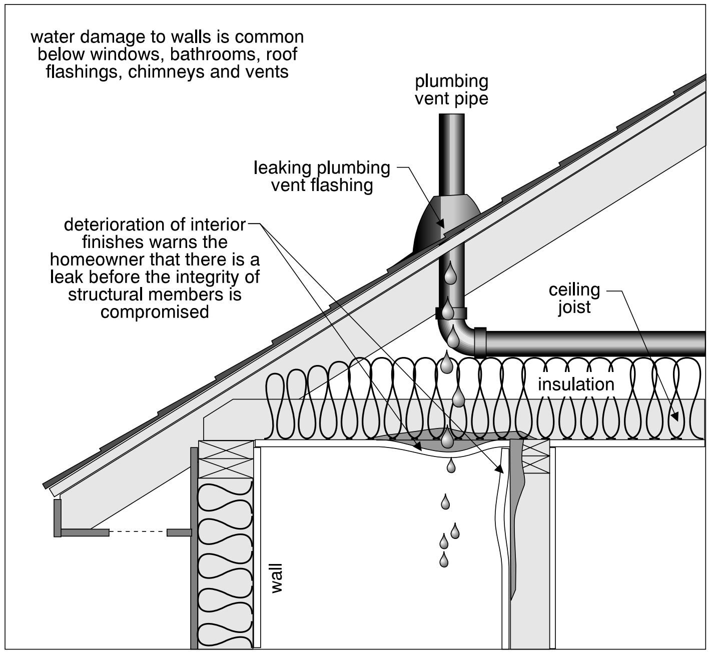
Localized repairs to any textured surface are usually noticeable because the texturing is difficult to match. Painting is more difficult than a flat surface, and wallpapering is usually not possible. The strength and durability is similar to plaster or drywall, although small projections are easily worn off the surfaces, if people or animals brush against the wall.

► 3.0 MAJOR CEILING FINISHES

Water Damage: Water damage is one of the most common problems on interior finishes. The water damage may be on walls, floors or ceilings. There are five areas of interest, typically, with any evidence of water damage. It is helpful to know a) the source of the damage, b) whether it is still active, c) whether there is any concealed damage, d) what the cost is to cure the problem, e) and subsequently what the cost is to repair the damaged building materials.

Common sources of water damage include roof leaks, flashing leaks, ice damming, window and skylight leaks, plumbing leaks, leaks from hot water heating systems, and condensation. Water damage may also result from such things as aquariums, room humidifiers or dehumidifiers, over-watering of plants, melting snow and ice from boots during wintertime, etc.

Common locations for water damage



Roof leaks are usually localized and the source of the problem will often be an intersection or a flashing in the roof. Roof leaks can be difficult to trace because the water does not always appear on the interior immediately below the leak above. This may be the result of water running along framing members, or vapor barriers which prevent water coming through in specific locations. Many roof leaks appear first around ceiling light fixtures, for example.

Water damage often looks more serious than it is. Short term exposure to water will not harm most building materials. Plaster and drywall, however, are damaged very quickly by water. The material which can be easily seen is the first material to deteriorate. It is unusual to have extensive building damage done by water which appears at an interior finish, as long as the problem is solved promptly.

3.1 Plaster/Drywall: Plaster and drywall are essentially the same material, Drywall is premanufactured while plaster is mixed and applied by trowel on site. Plaster and drywall are made largely of gypsum. In some cases, aggregate or fibers are added to the gypsum as stabilizers and strengtheners. Horse hair was one of the materials commonly added to older plaster to help strengthen it. Lime may be added to improve workability.

These interior finishes are very common because they are inexpensive, relatively easy to apply, and afford good fire resistance.

Wood Lath

Older plaster systems typically employ a wood lath which is comprised of boards roughly one inch wide by one-quarter inch thick. These "yardstick" type boards were nailed to the joists or rafters, with roughly one-quarter inch spaces between boards. The plaster was then trowelled on in two or three coats. The first layer of plaster would ooze through the spaces between the wood lath, and harden to form a "key" which held the plaster onto the lath. This first layer is called a "scratch" coat. Where a three step process is used, the second coat is called the "brown" coat and the third is a "finish" or "putty" coat. In a two step process, there is still a scratch coat and a brown coat but they are applied one immediately after the other. The finish coat is applied after the brown coat has set.

Gypsum Lath

In the late 1930's, gypsum lath became popular. These premanufactured plaster sheets replaced the wood lath because they were quicker and less expensive to install. The gypsum lath was paper covered similar to drywall. It came in sizes that varied, but was typically sixteen inches by forty-eight inches. The gypsum lath was typically provided with one or two finish coats of plaster and the total thickness of the system would be approximately 1/2 to 5/8 inch. The lath itself is typically 3/8 inch thick. Wire mesh lath was used in areas where reinforcing was necessary.

Drywall

Drywall became popular in the early 1960's, and is used almost exclusively today. There is very little difference between a properly executed drywall and plaster job. Poor drywall work is usually identified at the seams. Sections of drywall are typically four feet by eight, ten, twelve or fourteen feet. Drywall is typically available in 3/8 inch, 1/2 inch and 5/8 inch thicknesses. The seams between boards must be taped and filled with drywall compound. If the taping and finishing work is poor, the seams can often readily be seen.

Damage

Problems: Both plaster and drywall can be readily patched where small damaged areas are noted. Re-drywalling over old plaster or drywall is sometimes done where large areas are damaged. Where plaster has lost many of it keys, due to the vibration and wear and tear of everyday living, large sections of ceilings may become loose. Where there is danger of plaster falling, this should be corrected promptly. People can be seriously hurt by plaster falling, especially from a ceiling.

Removal of the old plaster, and replacement with new plaster or drywall is the preferred approach. However, removing old plaster and lath is messy, disruptive, and time consuming. Adding new drywall over old plaster is common and may be acceptable. It is critical to attach the drywall through the old plaster to the joists or rafters. Attaching the drywall to the plaster may only accelerate the plaster coming off. Adding new plaster or drywall over ceilings may result in decorative mouldings appearing recessed into the ceiling.

Another option is to replaster over old plaster. This is often accomplished by fastening wire lath over the old plaster and then applying plaster in the common two or three step process. Applying a new finish directly over cracked, loose plaster may accelerate the deterioration, due to the added weight.

Shadow Effect

A common problem with plaster applied over gypsum lath is the shadow or bulge effect. This was created when the plaster was applied too quickly. The finish coat was sometimes applied before the first coat dried completely. The moisture was driven back into the gypsum lath which sagged. The result is a pattern visible in the wall or ceiling that shows seams every sixteen inches in one direction. Sometimes seams are also visible perpendicular to these, at thirty-two or forty-eight inch intervals. This pattern is often only visible with a bright light shining across the plaster surface.

The problem is not progressive. No repairs are necessary. If improved appearance is desired, a skim coat of plaster can be added, depending in the condition of the surface. A plasterer should be consulted.

3.2 Acoustic Tile: These tiles, typically made of fiber board and perforated to improve their acoustic performance, have been popular since the 1950's. Typically, they are twelve inches by twelve inches and are stapled or nailed to strapping. This type of ceiling tile was often installed when finishing a basement, or was installed over a damaged plaster ceiling.

Problems: The tiles do have better acoustic properties than plaster and drywall, although they are subject to mechanical damage and water damage, similar to drywall or plaster. Repairs are easy if matching tiles can be found. The tiles can be painted, with some loss of acoustic performance.

3.3 Suspended Tile: Suspended tile became popular residentially in the 1960's, and can be made of fiber board or fiber glass, for example. Some have a plastic coating. Combustible plastics, such as polystyrene, should not be used as ceiling tiles. This system utilizes a metal T-bar grid supported by wires from the original ceiling. One disadvantage of this type of system residentially, is that it does require lowering the ceiling at least two to three inches. Advantages include relatively good acoustic properties, ease of removal to access anything above the ceiling, and individual tiles can be replaced readily.

3.4 Metal: Metal ceilings were typically made of tin and most often were installed in kitchen areas residentially, during the late 1800's and early 1900's. Their design was often a decorative square pattern intended to simulate the look of ornate plaster ceilings. This was a fairly durable ceiling system and in some areas has become fashionable again. The metal is normally painted.

3.5 Stucco/Textured/Stipple: Interior stucco is essentially plaster, and is typically installed in a two or three coat process. The finish is sculpted or worked to provide a decorative appearance. The texturing is done with trowels, sponges, brushes, or other tools to give the desired effect. In modern construction, a sprayed on one-coat stipple finish is often used over drywall. This textured finish is inexpensive and quick to apply. It does not, however, cover poor drywall work, as flaws will show through. It should also not be used in kitchen or bathroom areas since the uneven surface is very difficult to clean. Localized repairs are usually noticeable because the texturing is difficult to match. Painting is more difficult than a flat surface, and wallpapering is usually not possible. The strength and durability is similar to plaster or drywall.

► 4.0 TRIM

Baseboard and Quarter Round

Most houses have some interior trim including baseboard, quarter round and door and window casings. Baseboard and quarter round are usually wood members which are installed at the intersection of the walls and the floors. Baseboard protects the bottom of the walls from things like brooms and vacuum cleaners, and also serves to provide a finished joint between the walls and floor. Baseboard can be anything from a two inch high piece of plain lumber to an intricate two or three piece architectural moulding, ten or twelve inches high. Quarter round is usually relatively small (approximately 3/4 inch radius) and covers the joint between the floor and the baseboard. Most often, it is the same material as the baseboard. Some modern architectural treatments omit quarter round, and occasionally baseboard is omitted as well.

In some high quality homes, other materials, such as tile or marble, are used for baseboard. This is an expensive treatment, of course. A commercial treatment occasionally found in homes is broadloom turned up the wall to form a carpet baseboard.

Casings

Door and window casings provide a finished look to the junction of a wall and door or window opening. Again, the casings are most often wood and may be quite simple or very elaborate. Some modern architectural styles include no trim work around doors and windows.

Cornice Moldings

Moldings at the junction between walls and ceilings are typically referred to as cornice moldings. They may be made of wood, plaster or foamed plastic. Depending on the age and quality of the house, these can be very elaborate. In modern conventional housing, these are not used to any great extent.

Medallions or Rosettes

Ceiling medallions or rosettes are usually plaster details found around light fixtures on ceilings. These details were common only in principal rooms such as living rooms or dining rooms. They can be fabricated on site, or premanufactured systems can be purchased and installed in any home. Reproduction medallions in foamed plastic are now available.

Trim Functions

These trim details perform few functions other than to protect exposed joints or comers. They add architectural appeal to a home, and better quality moldings and trim may mean better quality construction. They may provide clues as to the original quality of the house and can help to date additions or renovations

Missing Loose and Damaged

Problems: Wood trim can, of course, be missing, damaged or loose. Where there is elaborate or specialized, replacement with an exact matching system may not be practical. Custom millwork is very expensive. Also, some of the woods used in the past are not available today. It is sometimes more cost effective to replace the entire trim in a room rather than try to match a section of old trim which has been damaged beyond repair.

When wall to wall broadloom was installed in some houses, quarter round was often removed and not replaced. Removing the broadloom usually necessitates at least some trim work.

When replacing windows or doors in a home, it may be necessary to replace trim work as well.

Plaster trim such as cornice moldings, ceiling medallions, et cetera, is difficult to repair if damaged (for example, by water). Rebuilding or repairing a damaged molding is time consuming and requires some plastering skills. There are, however, still people available to do this sort of work, if one is willing to pay for it.

Water Damage

Water damage is one of the most common problems on interior finishes. Please refer to Section 3.0.1.

► 5.0 STAIRS

Stairs and stairwells form part of the interior finish of a home. Structural problems related to stairwell openings are addressed in the Structure section.

Components

The stairs themselves are typically made up of stringers, treads and risers. The stringers are the long diagonal supports for the stairs which rest on the floor of the lower story and are usually secured to the side of a floor joist on the upper story. The stringers are almost always made of wood (e.g. 2 x10), although they can be metal. There are usually two stringers, although there can be one or three. The treads are the components on which people step and the risers are the vertical members at the back of each tread. Again, treads and risers are most often wood. Open staircases do not have risers.

Rise, Run, and Tread Width

Stairwell terminology includes “rise and run”. The run is the horizontal distance from one riser to the next, measured along the tread. The run is usually less than the tread width because the tread has a nosing which projects beyond the riser below. For example, it is typical to have a tread width of ten inches and a run of nine inches. The rise is the vertical distance from the top of one tread to the top of the next. The rise and run for each step must be the same in any staircase.

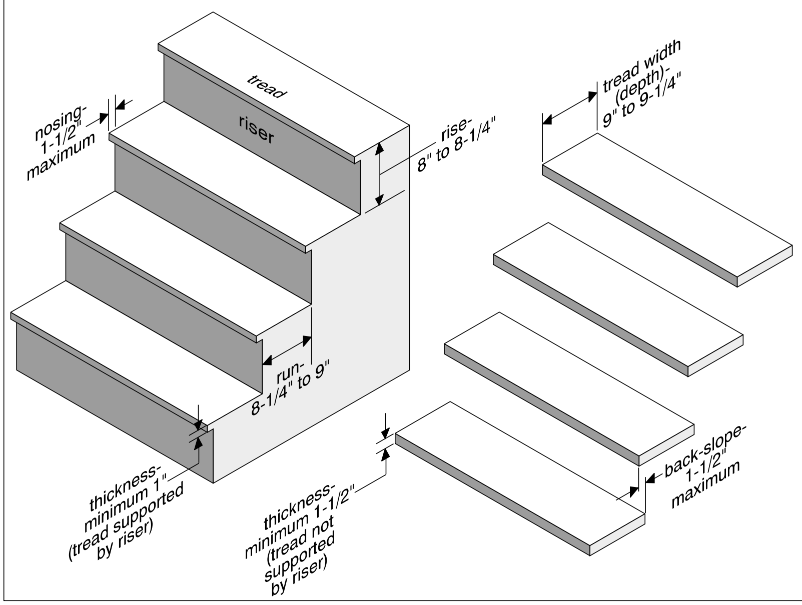
Minimums and Maximums

Good stair design has a maximum rise of 8 to 8-1/4 inches, a minimum run of 8-1/4 to 9 inches and a minimum tread width of 9 to 9-1/4 inches. Generally speaking, the lower the rise and the wider the tread, the more comfortable the staircase is to use. Dimension rules are often broken on basement and loft stairwells. It is very difficult to rearrange a poorly built staircase and, in most cases, the occupants simply learn to live with it. The rules of thumb vary somewhat, area to area.

Width and Headroom

A stairwell used on a regular basis should be at least 34 to 36 inches wide. Wider stairs are more pleasant and make it easier to move furniture. The headroom above each tread should be at least 6 foot, 5 inches to 6 foot, 8 inches. More is better, but less is common on basement stairs. Again, it is rarely worth changing.

Stair dimensions (straight stairs)



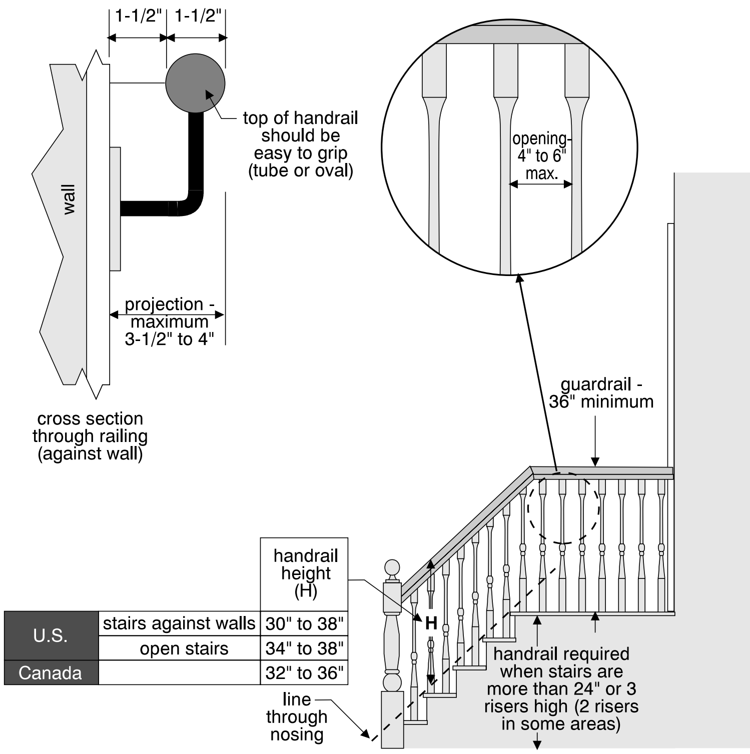
Doors and Landings

Where there is a door at the top of the set of stairs, it should open away from the stairs. If it opens towards the stairs, there should be a landing so that someone coming up the stairs won't be knocked down by another person opening the door. If an unsafe situation exists, it is usually less expensive to rearrange the door than to add a landing. This situation is sometimes created on older homes where a storm door has been added. The original front steps come up to a door which opened into the house. The storm door has to open out and, when added, creates an unsafe situation. Ideally, the stairs should be rebuilt with a landing.

Curved Stairs and Winders

Curved stairs or stairs with winders are not considered as safe as straight stairs. The treads often get very narrow on one side. Many codes accept some runs on curved stairs as narrow as six inches. Winders are pie shaped treads which disappear to a point at the inside edge. These are not desirable, but are common. Winders usually appear in groups of three and should not turn through more than 30° each. The total set of winders should not turn through more than 90°. Spiral staircases are built entirely of winders and, in many areas, are not permitted as the only way to get from one floor to another. The thinking is that in a fire these staircases are dangerous because they are difficult to get down quickly.

Handrails and guards



		handrail height (H)
U.S.	stairs against walls	30" to 38"
	open stairs	34" to 38"
Canada		32" to 36"

Railings

Railings are recommended on at least one side of each staircase with more than two risers. Railings on stairs in new construction are usually required to be thirty-four to thirty-eight inches high in the U.S.A. and thirty-two to thirty-six inches high in Canada. Railings around the top of open stairwells should be at least thirty-six inches high. On older homes, railings are often lower and, rather than rebuilding an elegant railing, most people live with the lower one. Where children's safety, for example, is in question, a higher temporary railing can be added.

Many codes do not limit the size of openings in railings in single family homes.

Where there are small children or other reasons for concern, a good rule is no opening larger than four inches in diameter. Some codes use a six inch rule. Most modern railing systems comply with this. In the same sense, stairs with open risers may be unsafe where a small child can crawl through the opening between two treads.

Problems: Stairs may be poorly supported if the floor system is weak or if the stringers are underdesigned, damaged or have shifted. Where a side stringer has pulled away from the treads, the treads may lose their support and fall out. Loose, worn or poorly supported treads are a safety concern.

Stairwells which violate size or uniformity rules are difficult to negotiate and may lead to an accident. Missing, weak or poorly arranged railings are a similar concern. Unfortunately, these situations are common in older homes and may not be cost-effective to rearrange.

► 6.0 WINDOWS

Windows provide light and ventilation for homes, at the expense of some heat loss (windows let more heat escape than even an uninsulated wall). They also allow air leakage, and can allow water leakage if poorly installed or maintained. Well designed windows add to the aesthetic appeal of a home.

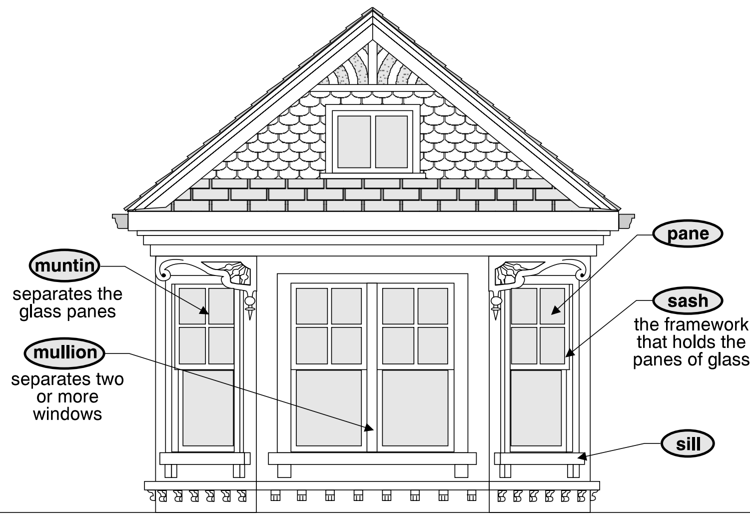
Anatomy: There are several types of windows, but some components are common to most. Some of the main components are described here. The pieces of glass in a window are called "panes" or "lites". The panes are held in a sash, which may move as the window is opened. The sides of the sash are called the stiles, and the top and bottom pieces are the rails. When the window within the sash is divided up into several small panes, the dividing pieces are muntins. The sides of the window frame are the jambs, the sill is the bottom assembly of the frame, and the head is the top. The casing or trim covers the edge of the frame where it meets the wall finish. There may or may not be a casing on the inside and outside of the building.

Putty or glazing compound is used to hold the glass in the sash in traditional window systems.

Conventional window glass is 3/32 inch to 1/8 inch thick. Thicker glass is sometimes used where increased strength or thermal insulating value is desired.

Glass may be strengthened by tempering. Fully tempered glass is made three to five times stronger than ordinary glass by heating it and then cooling it very quickly. Tempered glass is also safer than ordinary glass because it breaks into small rectangular particles. Tempered glass is used in sliding doors and skylights, for example.

Window components



Glass can be tinted to reduce glare or absorb heat. Heat can also be reflected with coated glass. Wired glass provides additional fire resistance, but may actually be weaker than conventional glass. Some experts feel it is more dangerous to humans if broken. Someone putting their hand through any pane of glass will usually be cut. Because the wire holds the pieces of glass in place, the person may be cut more severely pulling their arm back through wired glass.

Laminated glass is a sandwich made up of two or more layers of glass and a plastic film between. Depending on what is desired, laminated glass can improve strength, safety and/or sound insulation. When the term "safety glass" is used, it may mean the glass is tempered, wired, laminated or a combination.

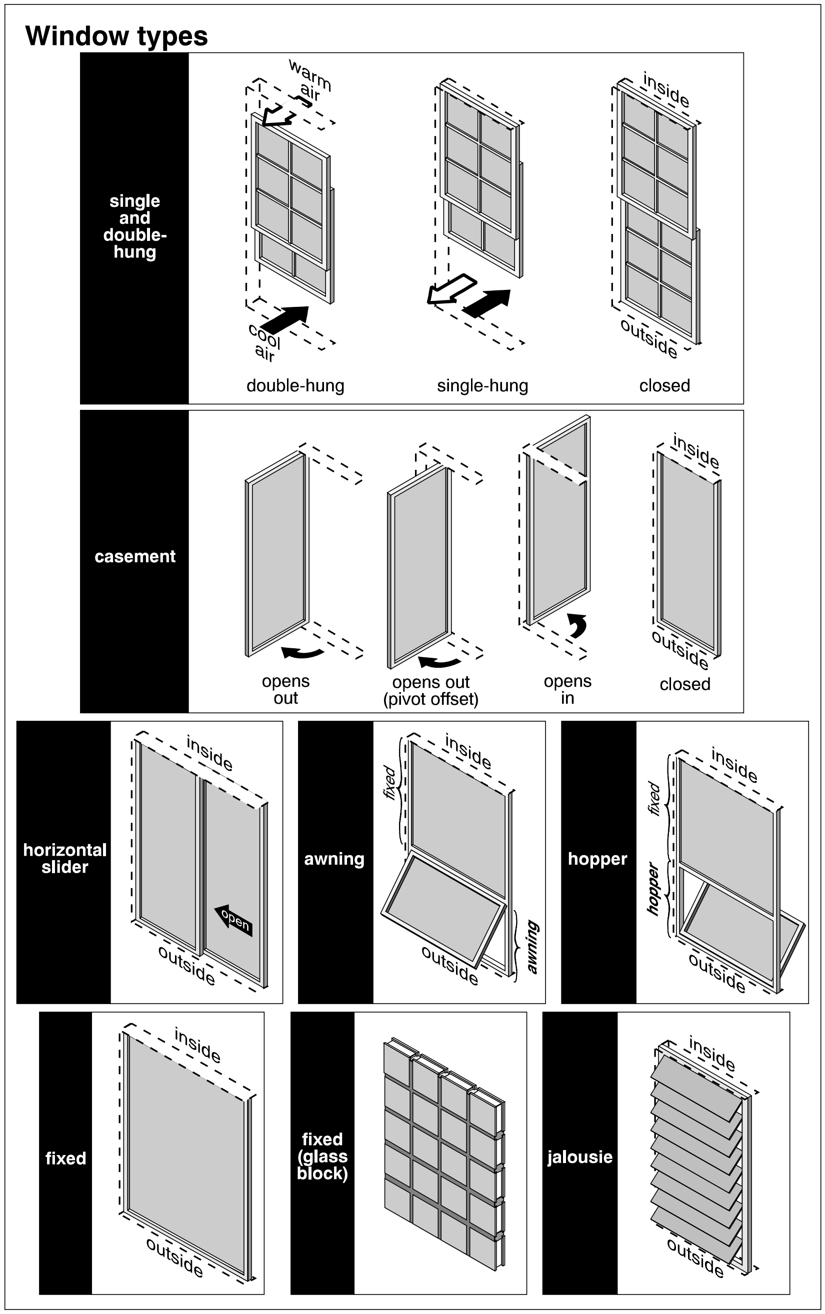
For privacy or architectural appeal, glass can be etched chemically, sand-blasted, painted, tinted, stained or given a reflective coating.

6.1 Major Window Types - Primary

6.1.1 Double Hung: A double hung window is made of two moving parts, with an outer part in the top half of the opening and an inner part on the bottom half of the opening. The windows move up and down in their guides. Traditionally, both the top and bottom halves could be moved up and down.

Typically, the top half becomes inoperative with painting and is rarely used. The bottom half should be kept operative. Early double hung windows were held open by the use of a counterweight system. A sash cord is attached to each side of the window. The sash cord goes up and over a pulley near the top of the side frames. The weight travels up and down in a channel in the frame. The weight holds the window in place when it is raised to the desired height.

Some modern double hung windows use a spring loaded mechanism concealed in the side of the sash. A spring is wound up as the window is raised and lowered, holding the window in place. A spring loaded coil tape is another way of holding a double hung window open.



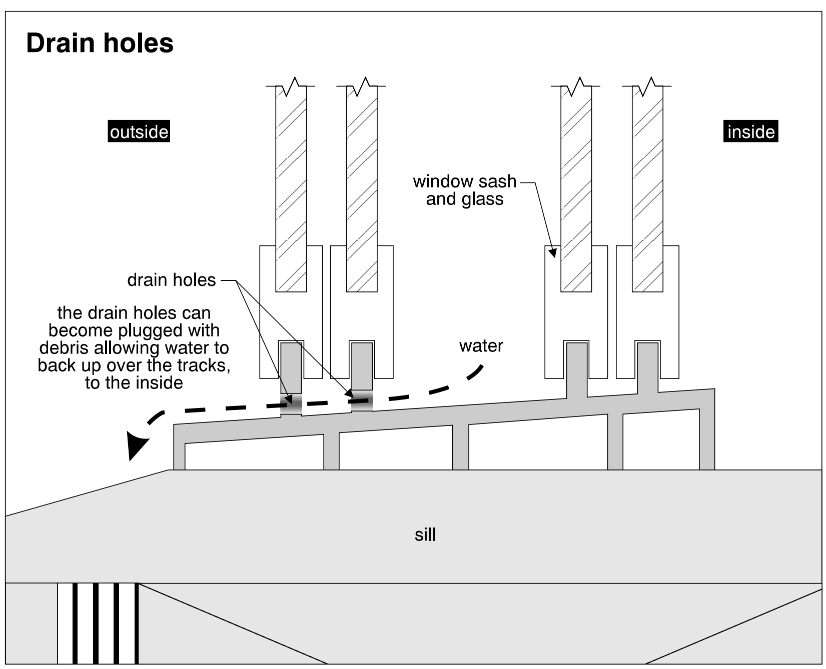
Some modern high quality double hung windows are pivoted at the bottom, and when release pins at the top are moved, the window can be rotated out of its normal operating plane, into the room so that the outside of the glass can be easily cleaned without going outdoors.

Double hung windows may be wood, metal, vinyl or a combination. The glass may be a single, double or triple pane in each half of the window. Wood, metal or plastic muntins may be used to create several smaller panes. Modern windows often employ artificial muntin systems set inside the window to give the appearance of several smaller panes. A lower quality version of this includes tape applied directly to the glass to look like muntins.

6.1.2 Casement: Casement windows are hinged at the side and open inward or outward. There is usually a handle on the side of the window opposite the hinge, and in some cases, a guide bar along the bottom of the window. An operating crank is often included at the bottom of modern casement windows. Glazing may be single, double or triple. Materials may include wood, metal, vinyl, or a combination thereof.

Wood muntins may be used to break the glass up into smaller panes. This is done on older or traditional style houses. Casement windows have become very popular as replacement windows. They can provide very good ventilation and, if well made and installed, can be very weathertight. Larger casement windows require good quality hardware to ensure smooth operation.

6.1.3 Sliders: Horizontal sliding windows have become popular in the latter half of the 20th century. Several low quality sliders have given this style of window a somewhat tarnished reputation. Some of the windows are nothing more than simple panes of glass with knobs attached on the surface of the glass. They typically travel in a wood or vinyl track. These are poor quality windows, subject to considerable air and water leakage. Better sliders are provided with sashes (metal, vinyl or wood) around the glass. Sliders are relatively inexpensive, and have very simple locking hardware as a rule. If well made, their performance can be as good as any other type of window. Glazing may be single, double or triple.



Problems include low quality hardware subject to breakage, tracks at the bottom which don't drain water to the outside, poorly fit slides, and poor joints at comers of the frames. Leaks often result in water damage to wall finishes below the windows, most often at comers. Exterior caulking may help in some cases; in others, storm windows added on the outside improve weathertightness. Where the problem is chronic, replacement windows may be the best answer.

6.1.4 Awning: Awning windows are hinged at the top and typically swing out. In most cases, there is an operating crank at the bottom of the window. Typical materials include wood, vinyl and metal. Glazing may be single, double or triple. These windows are not terribly common, although in one sense, are desirable. These windows, if left open during the rain, are less likely to allow water penetration into the house than most other types. The amount of ventilation they permit is good, although unless the hardware is well made and the windows well fit, operating can be difficult.

A variation on the awning window is the hopper window. This is hinged at the bottom and may open in or out. These are not a popular design as they catch rain and debris if they open outward, and interfere with furniture placement if they open inward.

6.1.5 Fixed: Fixed windows, sometimes called picture windows, are simply a pane of glass fit into a window opening and held in place with stops. The glass can be anything from a single pane of minimum thickness glass to double or triple glazing, to a full six inch thick glass block. There is obviously no ventilation capability for fixed windows. Large windows are expensive to replace and handling picture window glass can be difficult and dangerous because of its size.

Replacement Windows

6.1.6 Window Problems: Windows are relatively complex systems and can suffer several problems. Where difficulties are experienced with several windows in a home, it may make sense to replace the windows. However, this is rarely cost-effective. Replacement windows are expensive and, in most cases, will not pay for themselves in reduced heating costs over a reasonable number of years. Where replacement windows are installed, it should be appreciated that some of the price being paid is for the improved appearance, reduced maintenance and ease of operation. Some improvement in room comfort and energy consumption will also be enjoyed, although these items cannot, on their own, justify new windows in most cases.

Glass

Panes of glass may be missing, broken or cracked. In some cases, panes of glass work loose and will rattle on windy days. On older houses where windows have been painted a number of times, the glass may be heavily covered with paint. Removing this paint often scratches the glass, impairing visibility. Older glass has more bubbles and distortions, although this cannot be considered a defect. Manufacturers' flaws include discoloration, clouding and rust streaking of the windows. In some cases, distortion may also be a problem. Double or

Lost Seal

triple glazed windows may lose their seal, resulting in intermittent or permanent condensation or clouding between the panes of glass. It may not be possible to identify a failed seal during a home inspection. The corrective action for these problems is replacement of the glass. Unless the glass is missing or broken, replacement of the glass is not a priority item.

Putty The putty or glazing compound holding a window in place may be deteriorated, loose or missing. This is normally improved during regular repainting.

Muntins Muntins between panes of glass may be broken or cracked. Loose muntins should be resecured. Where the muntins are lead (typical of homes built in the first half of the 20th century, often with diamond shaped panes of glass), the windows tend to bulge inward or outward. This is thought to be a result of impact or the thermal expansion of the lead, and may be related to the addition of storm windows. Depending on severity, this can sometimes be repaired by a glass specialist, although, in some cases, the window has to be replaced. Specialty shops can reproduce leaded glass windows.

Sashes Wood sashes may be deteriorated as a result of mechanical damage, rot, or failed joints. It is not unusual to find the stiles and rails of wood double hung windows coming apart. This is often a result of people opening the window by lifting up on the top rail. Hardware attached to the bottom rail should be used for opening and closing double hung windows. Where this hardware is missing, it should be replaced. Metal and vinyl sashes may also fail, but this is less common than on wood.

On some vinyl horizontal sliding windows, it is common for the vinyl sashes to be pulled away from the glass. This is often because the sash is used to pull a window closed. It is better practice to push a horizontal slider closed than to pull on it, even though the manufacturer may provide pulling hardware.

Sash Cords Sash cords on double hung windows are often broken or missing. The pulleys at the top of the jamb are often inoperable, because they have been painted. Sash cords, incidentally, should not be painted; nor should the window guides in the frame. While cotton sash cords can last for many years, some people prefer to replace them with nylon or metal sash cords. The chain sash cords are somewhat noisier, of course.

Springs The spiral spring hardware used to hold up some double hung windows is prone to jamming, particularly if paint is introduced. It is also common for the springs to become detached from either the window or the jamb. Springs can break on this type of sash support. Similarly, springs on the coiled tape system can break. Again, painting of any of the operating hardware on windows may render it inoperative.

Condensation Sashes and frames on early metal windows are susceptible to condensation problems. Because metal is a good thermal conductor, the inside face of the metal can be very cold, promoting condensation on the interior of the building. Warm moist house air contacting the metal cools quickly, losing its ability to hold moisture. Modern systems have a thermal break, which keep the inside metal surface warmer. Vinyl frames can suffer similar problems. Some experts say it is important to have more of the thermal mass of a sill or frame on the inside (warm) side of a window to minimize condensation.

Sills Sill assemblies can be loose, rotted or improperly sloped. Manufactured window systems with a primary and a storm window typically have drain holes below the outer pane so that any water which accumulates between the inner and outer panes can escape. In some cases, these windows are installed backwards, with the drain holes on the inside and the sill sloping into the house. This, of course, results in damage to the walls below the sills on the inside of the house. Blocked drain holes are a related problem, but these are easily cured by removing the obstructions.

A common problem with manufactured window systems is a poor connection at the sill/jamb intersection. Water will accumulate on a window sill system from driving rains or condensation, for example. Although the sills should be sloped to drain water out, and there should be drain holes available to carry the water away, any imperfections in this system (or a very fast build up of water) will result in water pending on the sill for some time. If the comers of the sill are not tightly sealed to the bottom of the jambs, the water will leak out through the comers of the window. It is very common to see water staining or wall damage below the corners of windows. Sometimes caulking of this joint is adequate, although, in severe cases, the window has to be taken out and replaced or reassembled at the comers. The problem is aggravated if the outer pane is left open and only the inner pane is closed. While more convenient for the occupant, this allows wind driven rain to accumulate between the inner and outer panes.

Casings Window casings or trim may be loose, missing or damaged. While this is largely a cosmetic problem, some additional air leakage and resulting heat loss will often be noted where the trim fit is poor.

Heads The most common problem with the head of a window is a sagging lintel. If the lintel (beam) above the window opening is not strong enough, the window may be deflected. This can result in a window which will not operate, and ultimately the glass will break. In some cases this problem is progressive; in others, the window lintel will sag into position and then remain fixed. This problem is common where the opening is large, such as in the case of picture windows or sliding doors, for example.

Hardware Window hardware may be missing, broken or inoperative. In many cases, it is cheaper to replace hardware rather than try to repair or clean heavily painted hardware.

Caulking Caulking of windows should be considered in two separate areas. Caulking on the outside of the window should be done to prevent water penetration. Caulking on the inside of the windows should be done to prevent air leakage out of the house. There are several different types of caulking materials suitable for each application, and the manufacturers' recommendations or the recommendation of a specialist should be followed when choosing a caulking for a given application. Caulking is not a lifetime material and modest quality caulkings have to be replaced every one to two years.

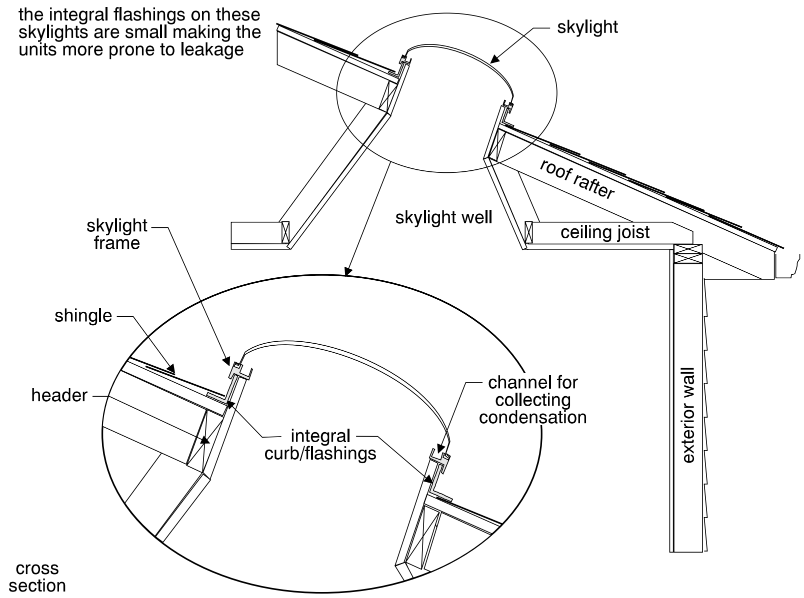
Screens Window screens may be aluminum, steel, bronze, fiber glass or nylon, for example. Metal screens may be rusted and all screens can be torn or pushed out of their frame.

Inoperable

Inoperable windows are very common and may be the result of paint or dirt in the operating mechanisms or tracks. Building settlement or swelling of wood components may also result in inoperative windows. Jammed, broken or missing hardware may also prevent easy operation.

6.1.7 Skylights: Skylights or roof windows have become popular residentially since the 1960's. Typically they use tempered glass or plastic and may be flat or bubble shaped. Older units or special-use skylights may have wired glass. Some skylights are operable, although most are not. Skylights are often installed after the house is built, and installation can be tricky. In addition to cutting a hole in the roof, (and the structural considerations brought on by doing that) leakage must be prevented where the skylight joins the roof covering. This can be difficult, as the skylight almost always presents a curb which will collect water. The skylight should have a flashing detail which makes a good watertight connection between the roof and the skylight.

Skylight in sloped roof - integral curb (self-flashing skylight)



Low quality and poorly installed skylights are very common and it is safe to say that most skylights have leaked at some point. Home-made skylights rarely perform well. Manufactured skylights should be installed following the manufacturer's recommendations. Flashing kits available from the factory should be used, where appropriate.

Glazing

Skylights and solariums often use acrylic or other plastic materials for panes instead of glass. These materials have better resistance to breakage than conventional glass, although they are subject to scratching. Abrasive cleaners should not be used on plastics, and overhanging tree branches should not contact the pane. Skylight glazing may be single, double (most common) or triple. Leakage is a common problem, although usually it is a result of poor installation rather than a poor quality fixture. It is often difficult to identify the source of the leakage without dismantling the system.

6.1.8 Solariums: Solariums are structures with the walls and roof made mostly of glass. They are also called sun rooms, Florida rooms, plant rooms and greenhouse rooms. The framing for the solarium may be wood, metal, vinyl, or a combination, and the glazing may be glass or plastic. Glass used in anything other than a vertical plane should be strengthened by tempering, or laminating. Glass used in roofs may have to withstand a falling tree branch or hail stones, for example.

Solariums are typically added onto a house and very often have three exterior glass walls. It should be understood that solariums are an indulgence in terms of energy, since glass is not a good insulator. These areas are expensive to heat and cool, and glass walls form an expensive building system, and one that is difficult to seat against water leakage. Even high quality solariums, if not perfectly installed, will leak around the roof and, in some cases, through the windows as well. Leakage is most common at the bottom of the glass roof areas, where good flashing details are difficult to achieve.

6.2 Predominant Glazing

6.2.1 Single: Until approximately 1950, virtually all windows were single glazed. This means that only one pane of glass was used in a window. In some cases, a thicker glass pane (up to one-quarter inch) was used in an effort to improve heating efficiency, although this makes very little difference. The additional thickness of the glass will give it some additional strength. Single glazed windows can be retrofit with a second pane added to the sash itself, although more conventionally, a storm window is added. The insulation value of a single conventional pane of glass is approximately R-1.

6.2.2 Double: Double glazing has become very popular, with the earliest common use residentially in the 1950's. Initially, double glazing was used primarily for picture windows, although now it is used on all windows. Double glazing may be either one of two types. Both are considered satisfactory.

Factory Sealed

The factory sealed double glazing is designed to have no air infiltration or exfiltration between the panes of glass. When these panes do lose their seal, they may develop condensation between the two panes, which makes it difficult to see through the glass. This reduces their insulating value only slightly. Replacement is not a priority from a functional standpoint. The condensation may disappear temporarily if sunlight warms the air between the panes sufficiently.

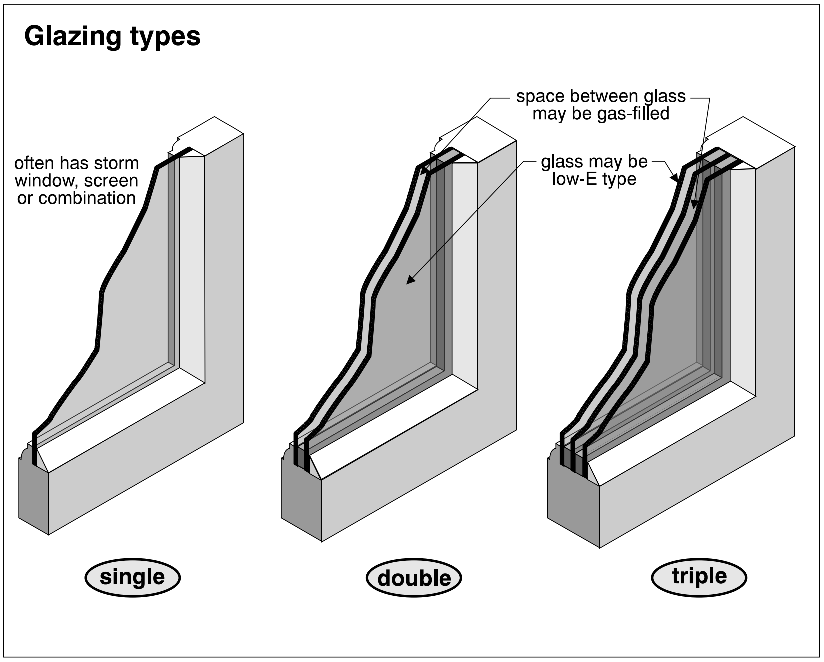
Vented

There are also ventilated double glazing systems wherein small holes between the outside air and the space between the two panes of glass allow for air movement. While condensation can develop here, it usually dissipates quickly. The ventilation holes can become clogged, which may trap condensation between the panes.

Space Between Panes

The space between the panes of glass does to some degree, affect the insulating performance of the glass. Generally speaking, an air space of 1/2 inch or less is common. An optimum air space is usually considered to be roughly 5/8 to 3/4 inch, although there is some disagreement among the experts. This space should be small enough to prevent convection currents, but large enough to allow a sufficient amount of air between the panes to act as an insulator. Some double glazed window systems include such things as venetian blinds between the panes of glass. These are expensive systems and are not seen commonly.

A typical double-glazed window has an R value of approximately 2.



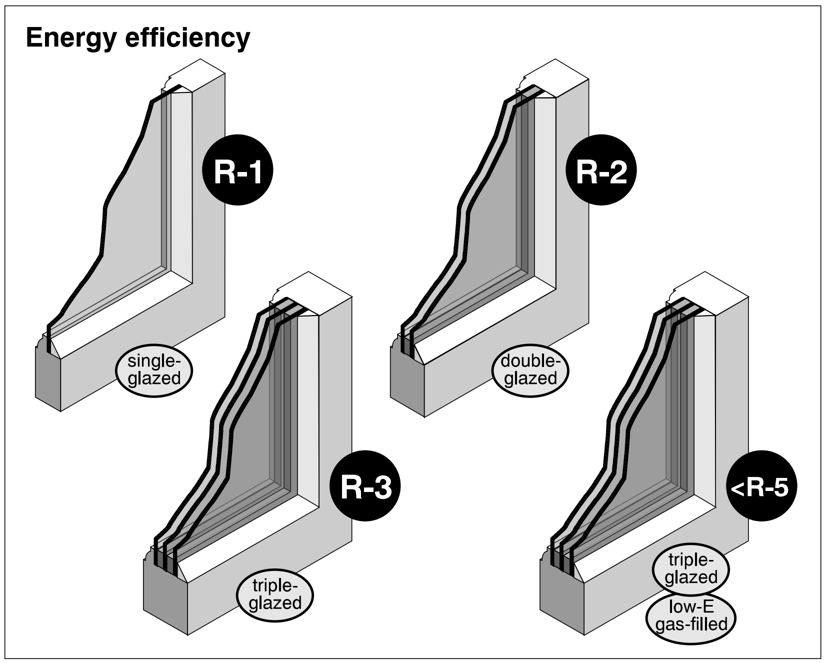
6.2.3 Triple: Triple glazing is becoming more common as energy costs increase. There are two air spaces between three panes of glass which do afford more insulating value. A seal which is lost may result in condensation between the panes. This obstructs visibility, and to some extent reduces the energy efficiency of the window system. A lost seal does not mean a window has to be replaced immediately. Most triple glazed systems have hermetically sealed air pockets between the glazing, rather than ventilated air spaces.

The insulating value of a triple glazed window is approximately R-3.

6.2.4 Primary Plus Storm: Many window systems include a primary (inner) window, and a separate storm (usually outer). The storm windows may be original to the house, or added later. It should be understood that the major benefits of storm windows are reduced drafts and reduced condensation.

The insulating value of a primary plus storm window is not significantly more than a primary window alone. Modern building codes require walls to be insulated to R-12 or more. A single pane of glass has an insulating value of roughly R-1. Interestingly, a double pane has an R value of 2. Adding a storm window does not make a window opening particularly well insulated. Triple glazing yields roughly R-3.

The air space between the primary window and the storm is often several inches. If it is more than four inches, the insulating value will be significantly reduced. A minimum air space between two panes of glass is generally one-half inch, with a three-quarter inch air space often considered to be about the optimum.



Condensation The additional seal afforded by the storm window does reduce air movement in or out of the house around the window opening. This leads to reduced energy costs as well as improved comfort. Adding a storm window has another benefit. During the winter months, a single glazed window has a very cold glass surface, inside the house, and out. Warm moist air in the house contacting the glass, will deposit condensation on the glass. This runs down the glass and can damage the window itself, and ultimately the wall below. The addition of a storm window makes the inner pane of glass warmer, preventing condensation under normal circumstances. In very cold weather, condensation may be noted on interior glass surfaces, even with double or triple glazing. This is a sign that the humidity levels in the house should be lowered.

Removable Storms

Until World War II, most of the storm windows were wood systems installed from the outside. Typically held in place with clips or brackets, they were put up every fall and removed in the spring. In some cases, screens replaced the storms during the summer months. Many older houses have no storms, and since there are no standard window sizes, add-on storm windows have to be custom made. Their fit is often less than perfect, and the storm window performance is compromised as a result.

Self-Storing Storms

Around the time of the Second World War, metal self-storing storms and screens became popular. Vinyl storms are also popular today. These are also called combination storms and screens, triple track storms and screens, or permanent storms and screens. They are typically comprised of a frame which contains two panes of glass and one screen. Most often there are two tracks. In the outer track, the screen sits in the bottom and a fixed pane of glass sits on top. On the inside track, there is a second pane of glass which is at the bottom, in front of the screen. This inner pane can be raised to open the window, providing ventilation. The screen and upper pane of glass do not move. These systems can usually be removed from the interior, which makes cleaning very easy. Other than that, however, these systems remain in place year round.

► 7.0 DOORS

Doors provide a way to enter and exit the house, of course, and can add to the architectural appeal of homes. Doors present a security problem in most houses. Most doors are a source of heat loss, due to poor insulating properties of common door materials (e.g. wood). Air and water leakage around door openings is also common. Some doors add natural light and ventilation (e.g. sliding glass doors) to a home. Exterior doors should be sturdy enough to offer some security, should stand up to weathering, should be fit tightly to minimize air and water leakage, and should include provision for locking hardware.

7.1 Typical Exterior Doors

7.1.1 Solid Wood: This is a traditional exterior door material. Wood has some natural insulating properties although weathertightness is always enhanced with the addition of a storm door. The heaviest wood door does not provide as much insulation value as even a poorly insulated wall.

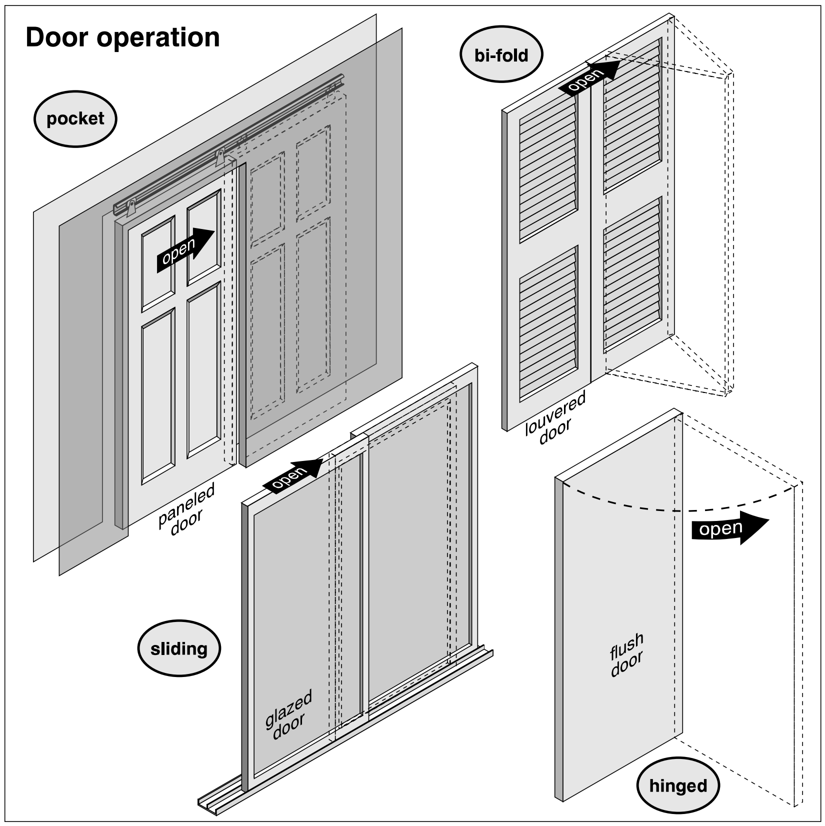
From a security standpoint, a solid wood door is relatively good, depending on the amount of glass area and, of course, the hardware and installation quality.

7.1.2 Hollow Wood: Hollow wood doors are generally not for exterior use. From energy, security, and durability standpoints, hollow wood doors are a distant second to solid wood. A common problem with hollow wood doors is deterioration of the wood veneer on the surface exposed to the exterior.

7.1.3 Metal (Insulated Core): This is a very common type of exterior door in modern construction. With a metal exterior skin and insulating material (typically polystyrene or polyurethane) inside, this can make a good insulating door. Another advantage of a metal door is that magnetic weatherstripping can be used to create a good air seal.

Metal doors often have decorative plastic moldings on the surface. Problems have been experienced when a storm door is added to an insulated metal door. The space between the doors can become overheated, and the plastic moldings may be affected. In the worst cases, the metal door panel may even buckle. Many manufacturers recommend against the use of storm doors with insulated core metal doors.

7.1.4 Garage Doors: Some municipalities allow doors connecting the house and attached garage. Where these are permitted, they should be treated as exterior doors. They should be weatherstripped to prevent automobile fumes entering the house, and should have an auto-closer so the door will not be left open. There should be a six inch step (minimum) going down from the house into the garage. Some jurisdictions require a fire-rated door.



7.1.5 Storm Doors: Storm doors have become very popular where the main door is solid wood. Most storm doors are metal although wood storms are also available. Many include a removable glass pane that can be replaced with a screen. Others have a self storing storm and screen system, similar to conventional storm windows. No matter how good a single exterior door is from a weathertightness standpoint, a storm door will usually improve the situation. The second door, if properly fit, will significantly reduce air leakage around the single door. Most storm doors are equipped with a self closer, and it is important that the closer be adjusted to close the door tightly to achieve a snug fit.

7.1.6 French: French doors are popular on traditional style homes, both old and new, and are becoming popular as a renovation feature. Historically, French doors have been weak in terms of their energy efficiency, although they are expensive systems and generally considered aesthetically pleasing.

Storm doors can be provided on French doors. This will improve the energy efficiency. The traditional materials are wood, although metal and vinyl doors are now available. Panes of glass are broken by muntins into small sections, or false muntins are provided to make it look like several smaller panes.

7.1.7 Sliding Glass: Sliding glass doors have been popular since the 1950's. They provide a large glass area with excellent visibility, and can provide a very large door opening, depending on the size of the unit. Sliding glass doors are available in wood, metal and vinyl or a combination thereof.

Early sliding doors that were made of metal were very poor insulators. A common problem with the early doors was the development of condensation and ice on the inside of the metal door frame. More recent treatments include a thermal break between the inner and outer halves of the metal frame. This keeps the inside metal part of the frame warmer, and reduces condensation and icing problems.

Sliding doors are typically two thicknesses of glass. Each pane can be in a separate sliding door component, or there may be one door sash with a double glazed or even triple glazed pane.

Better quality sliding glass doors are distinguished by more expensive hardware and sophisticated means of adjustment.

Some sliding glass doors do not have a locking mechanism that can be operated from the outside of the house by a key. This may be of concern where access to the house is most convenient through the sliding glass door.

7.2 Door Problems: Functional problems with doors include damage to the door material (rotted wood, buckled metal, et cetera). Door hinges which are damaged or poorly secured make doors difficult to open and close and, if not corrected, will lead to damage of the door and the frame. Latching mechanisms which do not work properly impair security. If the door is not properly weather-stripped, unnecessary heat loss is experienced. Frames which are damaged or out of square result in heat loss and doors which may be hard to open and close. Door thresholds which are loose or damaged are unsafe and should be repaired or replaced as necessary.

Storms

Storm doors which do not close properly are ineffective from an energy efficiency standpoint, and may be damaged in strong winds. Auto-closers should be adjusted as necessary. In some cases, the door frame has to be straightened or the door re-hung. Damaged glass should be repaired for safety, security, and heat loss reasons. Damaged screens and storm doors can also be safety concerns and should be repaired or replaced promptly.

Sliding Doors

Sliding glass doors often suffer hardware damage or the track becomes dirty and the doors will not operate easily. On older metal sash sliding doors, the damage to the building interior at floor level can be significant, as a result of condensation and ice build up. The absence of a thermal break in the metal frame leads to a very cold interior metal surface. The cold metal contacts warm moist air in the house. As the moist air is cooled, condensation develops as droplets on the metal frame. The water runs onto the floor, or forms ice temporarily and as it thaws, will melt and run onto the floor. This damages the door sill, floor boards, subfloor and, in severe cases, the joists and header below. Providing an additional sliding door on the exterior will minimize the problem, although this creates a door opening which requires a number of motions to open and close. The preferred solution is, of course, to replace the sliding door system. Typically on these older systems, the hardware is not in good shape in any case.

Damage to the frame is common on sliding doors. This is often caused by excessive force used in opening and closing the door, often necessitated by damaged or poorly adjusted hardware, or a dirty track. Where the guides or rollers have been mechanically damaged, the door will not ride freely.

The weatherstripping on early sliding doors was not high quality, and a good deal of air leakage can be experienced.

When sliding glass doors are installed in a newly created wall opening, a substantial lintel is required above the opening. Where undersized lintels are used, it is common to notice a sag over the sliding doors. Where the lintel is not extended far enough on to the wall beyond the opening at either end, it is possible for the lintel to slide off one end or to crush itself or the studs at the ends. If enough deflection in the lintel takes place, the doors will not operate freely.

Step Up

Ideally, all doors should have at least a six inch step up from the outdoors to the door sill. This is often omitted on sliding doors leading onto a deck, for example. Where this step is not present, snow accumulation on the exterior can leak through the bottom of the door system readily. Where no six inch step-up is noted, good inspection practices and regular maintenance (including snow clearing) are often necessary to prevent serious water damage.

The loss of a seal between double glazed panes on a sliding door is common. This results in a clouding of the glass which may be permanent. Because of the large panes of glass usually involved, this is a relatively expensive problem. Replacement is not a high priority as only a very small loss in energy efficiency is suffered. Replacement is usually undertaken because of the unsightly appearance of the clouded glass. Some door sashes are arranged so that they can he dismantled. Others are manufactured in such a way that this cannot be done. Replacement is, of course, more expensive in the latter case.

► 8.0 FIREPLACES

Fireplaces have been used historically for heating homes and preparing food. Today, fireplaces are primarily recreational. Most fireplaces take more heat away from a home than they provide and, in this sense, they are truly a luxury item. Fireplaces provide radiant heat into a room, but use the warmed house air for combustion. The air that goes up the chimney typically represents more heat loss than the radiant heat gain from the flames. A roaring fire can draw three hundred to four hundred cubic feet of air out of a house every minute. Heatilators, glass doors and outside combustion air intakes all work to reduce the heat loss.

Chimney Draw

There are many types of fireplaces, each with their own advantages. It is not possible to predict which fireplaces will draw well and which will be problems. Some draw well most of the time, but are troublesome under certain wind conditions. There are a number of solutions for poor draw discussed in this section. A rule of thumb to achieve good draw is that the chimney flue area should be one-twelfth the size of the fireplace opening. Where the top of the chimney is less than fifteen feet above the hearth, this is often adjusted to one-tenth.

Safety

Fire safety is a much greater concern than the quality of draw. Fireplace and chimney systems may be unsafe because of poor construction or installation, building settlement, improper usage or poor maintenance. Many safety related items are not visible. Where there is reason for doubt, it is best to engage a fireplace specialist. In any case, fireplace and chimney systems should be inspected and cleaned at least annually.

Foundations and Hearths

8.1 Masonry:

Traditional fireplaces include a footing and foundation system which is of the same material as the house foundation. The hearth (the floor of the fireplace) is typically four inches of poured concrete covered with at least one inch of firebrick, stone, slate or tile. The covering on the hearth outside the firebox can be thinner. The hearth itself should extend at least sixteen inches beyond the front of the fireplace and at least eight inches beyond either side.

Masonry Fireboxes

The firebox walls are usually brick, stone or concrete block with a firebrick liner. The liner is typically at least two inches thick on the sides and back, and the total wall thickness should be about eight inches. Where the back of the fireplace is the outside wall of the building, the wall need only be about six inches thick. The mortar joints in the firebrick should be a special refractory mortar and should be as thin as possible. No mortar is required in the firebrick on the hearth, since the bricks are not likely to move out of position.

Some early masonry fireplaces did not include a special firebrick liner. The common brick which was used will eventually break down and this should be replaced with firebrick when necessary,

Metal Fireboxes

Some masonry fireplaces have a metal firebox. In these cases, the walls of the firebox are steel plate. These can be satisfactory, although some fail by bowing or buckling. This is usually a result of inadequate clearance between the metal and the masonry. (A metal firebox, incidentally, should not be confused with a zero clearance fireplace or a fireplace insert. These are discussed elsewhere in this section.) The metal fireboxes have a masonry wall behind them.

Dampers

Masonry fireplaces should include a metal damper. The damper may be operated from outside the fireplace by a handle on the mantle face, or by a lever located inside the firebox. The first arrangement, although not common in modern fireplaces, is slightly more desirable. If a fire is lit with a damper closed inadvertently, the damper can be opened easily when the handle is outside the firebox. The damper handle itself should be two inches from any combustible materials on the surface of the mantle.

To ensure good draft, the damper should be at least six inches above the front of the fireplace opening. The damper opening should be as wide as the firebox, and the damper is usually closer to the front of the firebox than the back. Many dampers are designed so that when the damper is open, the damper itself will deflect down-drafts away from the fireplace.

Problems with dampers include rusting through, becoming jammed or misaligned. Perhaps the most serious problem is a missing damper. It is fairly expensive to install a damper where none was allowed for on original construction. Glass doors may be an acceptable alternative.

Smoke Shelf

The smoke shelf is located behind the damper and provides a deflection pad for down-drafts and rain or snow. Fireplaces designed for burning coal and most zero clearance fireplaces, for example, do not have a smoke shelf.

Smoke Chamber

The smoke chamber is located above the damper and below the chimney. The smoke chamber and chimney are typically brick, stone or concrete block. The smoke chamber is often covered with a special cement parging to provide a smooth surface. The side walls of the smoke chamber are sloped to direct the smoke from the wide damper opening into the narrow chimney flue. The slope of the smoke chamber wall should not be more than forty-five degrees off vertical and should slope evenly from both sides. Brick corbelling is not recommended in a smoke chamber. The smoother the walls of the smoke chamber, the more likely the smoke is to move freely through it,

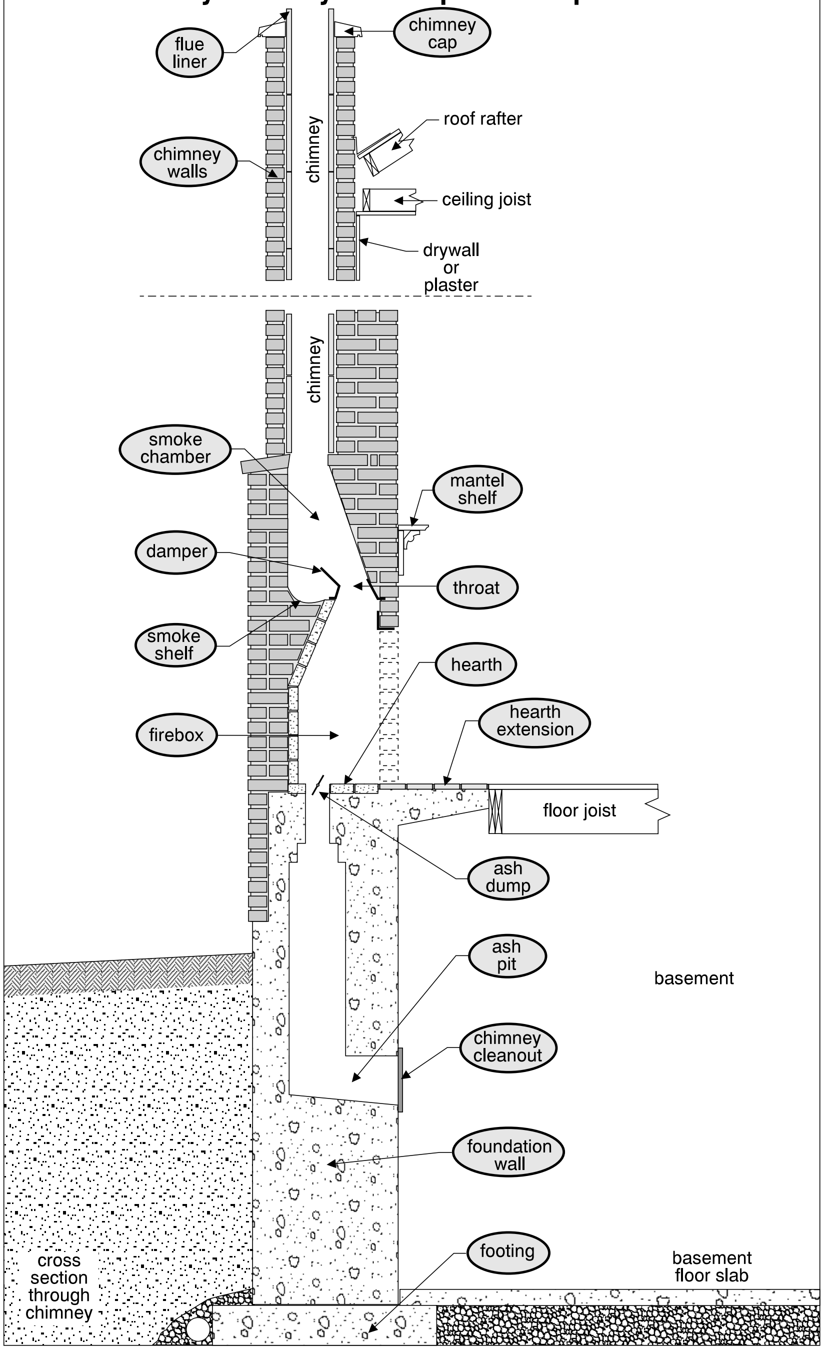
Chimney

The chimney itself is usually made of the same masonry unit as the fireplace and, since approximately 1950, clay tile liners, roughly 5/8 inch thick, have been provided on the inside of the chimney. The clay tile liners are usually assembled in two or three foot long sections and the joints should be mortared together. It is common practice near the top of the chimney to have a section of clay tile liner suspended on nails two or three inches above the section below. This gap is created so the top piece of clay tile will project the desired distance above the chimney cap. This gap in die liner is not a good practice and will lead to deterioration of the chimney masonry.

Mantles

Fireplace mantles should not have combustible materials within six inches of the fireplace opening. Where there is combustible material above the fireplace opening, and it projects 1-1/2 inches or more out from the surface of the mantle, it should be at least twelve inches above the opening. Many wood mantle shelves violate this rule and may be subject to overheating.

Basic masonry chimney and fireplace components



8.1.1 Ash Dumps: Some fireplaces have a trap door in the hearth to allow cool ashes to be dumped into a pit below the fireplace. The ash pit can be emptied from below. This eliminates the need to sweep ashes into a container and carry them through the house. Ash pits should be separated from combustibles by at least four inches of solid masonry. Missing ash dump doors in fireplace hearths should be replaced prior to using the fireplace.

8.1.2 Outside Combustion Air: Fireplaces have traditionally used warm house air for burning the wood or coal. This is wasteful, since the air has been heated by the furnace or boiler, and the fireplace can draw three hundred to four hundred cubic feet of air out of the house every minute. This air loss may also compete with the furnace or boiler for air, resulting in a dangerous back draft situation. When this happens, air moves down the furnace chimney bringing exhaust gases back into the house. Some of these exhaust gases are poisonous.

A solution which has become popular (and is now required by some codes) is to bring in some outside air for the fireplace. This is accomplished using a screened vent on the building exterior. A length of four inch diameter metal ductwork, insulated to approximately R-7, is used with a damper which can be operated from inside the house. A register is located in front of or inside the fireplace floor. If the register is inside the firebox itself, it should be hooded so that hot embers cannot enter the ductwork. The section of metal ductwork within three feet of the fireplace should be at least two inches away from any combustibles.

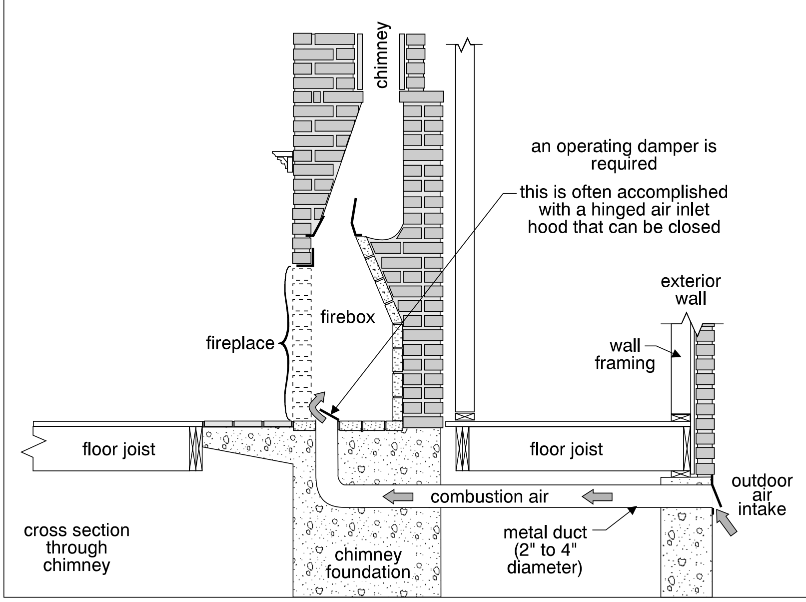
This arrangement provides outside air for the fireplace and minimizes the amount of house air lost up the chimney. The use of glass doors, in addition to this outside combustion air intake, essentially cuts the fireplace off from the house altogether.

Problem

Problems with this system include obstruction of the ductwork or outside air intake, especially if the intake is too close to the ground. If the screen is missing or broken on the inlet, it is not unusual for birds or other pests to set up house-keeping in the ductwork. If the damper is inoperative or ill-fitting, considerable heat loss may occur when the fireplace is not is use. On the other hand, if the damper is stuck in the closed position, the system is defeated.

Ductwork which is combustible or is too close to combustible materials is a fire hazard, of course, and uninsulated ductwork will result in added heat loss and possible condensation problems on the outside of the duct. If the register in the fireplace is not hooded, hot embers may enter the ductwork and create a serious fire hazard.

Outdoor combustion air



8.2 Prefabricated Or Zero Clearance Fireplaces: Zero clearance fireplaces have been popular since the 1970's. These are insulated metal units which are very light in comparison to masonry fireplaces. They can be located almost anywhere in a house, since a special foundation is not required.

Despite the name, care must be taken during installation to ensure appropriate clearances from combustibles, as recommended by the manufacturer.

Chimneys

These fireplaces are typically connected to metal chimneys specially designed for this use. A safe installation needs a good connection between the fireplace and chimney, good connection of the chimney sections, and proper extension of the chimney above the roof. The system should be well secured and combustible clearances for the chimney should be maintained.

Dampers and Glass Doors

Zero clearance fireplaces have a damper, but usually have no smoke shelf. Many include a built in heatilator system and some are approved for use with glass doors. Only the glass doors stipulated by the manufacturer may be used.

Inspection

Whether the fireplace is masonry or metal, it is impossible to conduct a complete inspection visually. Some faith must be placed in the manufacturer and installer. Manufactured units which have been approved by the appropriate authorities provide some assurance and, under the best circumstances, the installation is inspected before it is closed in.

8.3 Fireplace Inserts: Many conventional masonry fireplaces have a metal insert added in an effort to increase energy efficiency. These usually include a door on the front and operate much like a wood stove. The units are more energy efficient than open fireplaces and, if property installed, can be quite satisfactory. Many difficulties have been experienced, however, with poor connections between the insert and the original chimney. Very often the damper on the original chimney has to be removed or permanently opened to install the insert. None of the original masonry of the fireplace may be removed when installing an insert. Inserts are not allowed in zero-clearance fireplaces.

Once the insert is installed, it is very difficult to perform a good inspection, or to clean the chimney properly. Many experts recommend that the insert be removed annually for cleaning, although this is not an easy job.

8.4 Fireplaces Designed For Gas: Many fireplaces installed in the late 19th and early 20th century were designed for use with natural or manufactured gas. These systems typically employ a very small firebox and often have decorative marble, cast iron or ceramic borders around the fireplace opening. These are generally not suitable for conversion to wood-burning fireplaces without major improvements.

New natural gas fireplaces are also available, some of which do not even require a chimney. A natural gas fireplace can sometimes be installed in a masonry fireplace. In some cases, a chimney liner may be necessary. A natural gas fireplace cannot be used for burning wood.

8.5 Fireplaces Designed For Coal: Coal-burning fireplaces were common in the late 1800's and early 1900's. They typically employed cast iron grates with a pull-out drawer in the bottom to remove the ashes. Most units had two dampers and the firebox was both narrow and shallow. Some units had slotted, heavy, cast iron covers available to put over the entire opening.

These fireplaces are often used for burning wood, although most specialists recommend that this not be done without a careful examination of the fireplace and chimney system. Because these units are very small, they are not suitable for most wood fires. The coal-burning system usually included an insert which has to be removed to perform a proper examination. This is beyond the scope of a visual home inspection. These fireplaces are invariably old and should always be inspected by a specialist prior to using them, even for burning coal.

8.6 Roughed-in Fireplaces: Roughed-in fireplaces are common inclusions in modern construction. Often a roughed-in fireplace is provided in the basement. Some municipalities do not allow these to be left open, since a few home owners have tried to use them without building a proper firebox and damper system. A roughed-in fireplace generally means that an opening has been left with a connection to the chimney. It may require $2,000 or more to install an operating fireplace here.

8.7 Non-functional Fireplaces: Many decorative fireplaces look, at first, and even second glance, like working fireplaces. These were particularly popular in houses built from the 1920's to the 1940's. The presence of a decorative fireplace does not mean that a fireplace can be added inexpensively. Decorative fireplaces are not suitable for conversion, although, in some cases, a decorative mantle can be saved and reused. There is usually no chimney associated with a decorative fireplace.

8.8 Wood Stoves: Freestanding wood stoves and fireplaces are common in cottage areas and are often seen in family recreation rooms. A well manufactured and properly installed stove can be a safe and energy efficient system. However, many problems have been experienced with inappropriate installations.

Problems arise with inadequate clearance from combustible materials, and poor connections of the exhaust flue and chimney system. Each manufacturer has specific requirements for their particular product, and it is best to consult the manufacturer’s installation guide. Manufacturers will usually provide installation and operating directions, even if the system is already in place.

Many insurance organizations are concerned with wood stove safety, and it may be desirable to have a specialist inspect a wood stove installation. Because of the controlled and relatively slow bum of a wood stove, creosote deposits in chimneys can be a problem. All chimneys should be cleaned regularly, but special attention should be paid to wood stove chimneys.

Listing Organizations

Wood stoves may be listed by Underwriters Laboratories (UL),Underwriters Laboratories of Canada (ULC), Canadian Standards Association (CSA) or Warnock Hersey, for example. Installation clearances are set out in the listings for these units. Where a listing cannot be found on a unit, the following guidelines are typically used.

Floor Protection

Wood stoves should sit on a concrete floor or a protected wood floor. The wood floor should be protected with a noncombustible pad (sheet metal, for example) which extends eighteen inches beyond the stove door and eight inches beyond the other sides. On top of this should be eight inches of hollow masonry. Usually, two courses of four inch units are used, arranged to allow air circulation. Stoves which sit off the floor can rest on special metal plates with spacers. Masonry units can be omitted.

Combustible Clearances

Wood stoves should at least be five feet from an oil tank for a furnace. Stoves should be forty-eight inches from combustibles (even if covered by plaster or drywall) on all sides and sixty inches above. Clearances can be reduced if special protection is provided. It should be noted that a four inch brick wall built against a plastered wood-frame wall does not adequately protect the wall and no reduction in required clearances is permitted.

It should be understood that many installations will not meet the clearances indicated above. The original installation instructions may have called for less clearance. Standards have also become more stringent in recent years.

Side and rear clearances can be reduced by two-thirds if the wall is protected by metal sheets spaced out one inch from the wall. A reduction of one-half is acceptable if brick or ceramic is spaced out from the wall one inch.

Some certified wood stoves have combustible clearances as small as eighteen inches on all sides. Add-on heat reclaimers are not permitted on wood stoves.

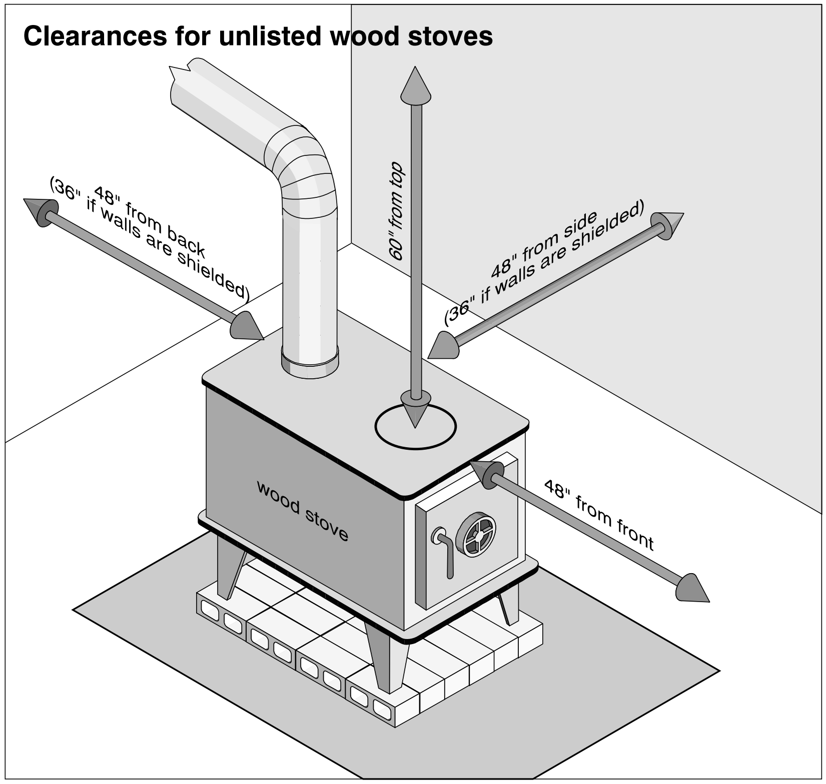
Chimney

A masonry chimney or a metal chimney, specially designed for solid fuels should be used. Under normal circumstances, the stove should not share a flue with any other appliance. Under no circumstances should a stove share a flue with an appliance on a different story.

Flue

Flue pipes or breechings (the pipes that join the stove to the chimney) should have no more than ten feet of horizontal run, no more than two ninety degree elbows, supports every three feet, and should have joints which allow condensate to drain into the stove. This last item means that where joints have one sleeve that fits inside another, the lower sleeve should be outside the upper sleeve. The minimum flue slope up from the stove to the chimney is 1/4 inch / foot. The flue/chimney connection should be tightly made with a thimble or flue ring.

The exhaust flue pipe should not extend into the chimney flue opening. Flue pipes should have a melting point above 2,000 degrees F., and should not be made of galvanized steel. The flue pipes should be kept at least eighteen inches from combustibles, including wood-frame walls covered with plaster or drywall.



8.9 Fireplace and Wood Stove Problems: Fireplaces may be unsafe for a number of reasons. Common problems include cracked hearths (often a result of building or fireplace settlement), deteriorated firebrick, inadequate clearance from combustibles (walls, mantles, lintels, et cetera), openings in the fireplace or chimney (as a result of building settlement, poor construction technique or deterioration of materials). Wherever safety related problems are suspected, a specialist should be engaged.

Hearths

Many fireplace hearths are undersized. They should project sixteen inches out in front of the firebox and eight inches beyond either side. Improvements may or may not be cost-effective, although with small hearths, close attention must be paid to sparks and embers.

Poor Draw

Poor draw on a fireplace may be the result of a chimney which is too short, a flue which is too small, a fireplace opening which is too large, a poorly shaped firebox, a damper which is too small, too low or too far back, a rough surfaced or poorly shaped smoke chamber, an excessive offset in the chimney flue (more than forty-five degrees), the absence of a smoke shelf, or inadequate combustion air. Another simple cause for a smoking fireplace is the fire being too close to the front of the fireplace. Moving the fire back will solve this problem. If the fireplace is too shallow to permit this, the fireplace may have to be rebuilt.

A chimney breast which is too thick may also result in a smoking fireplace. Ideally, the breast should be no more than four inches thick.

A dirty chimney can result in a smoking fireplace because it is difficult to fully open the damper, or the accumulation of debris on the smoke shelf will change the direction of air movement in the chimney.

Most fireplaces break at least some of the rules of good design. The trick is not to create the perfect fireplace, but to correct the most serious flaws as economically as possible. Generally speaking, simple solutions should be tried first, and more substantial work only undertaken if the inexpensive approaches are unsuccessful.

Straightforward solutions include reducing the fireplace opening size (for example, by adding more firebrick on the hearth), extending the chimney upwards, or adding glass doors. In some cases, adding a rain cap on the chimney top will prevent down drafts and cure the problem. Adding combustion air may solve a smoking problem and may also improve the safety of the house, while at the same time, reducing heat loss. Where these do not work, a specialist should be engaged and more extensive work will be required.

Metal Fireboxes

Metal fireboxes should be kept one-half inch to one inch away from masonry. The gap should be filled with noncombustible insulation. Where this gap is not provided, the metal firebox may buckle as it expands during a fire. In some cases, the masonry will crack. The metal and/or masonry may have to be replaced, depending on the advice of a specialist.

Zero-Clearance

Unsafe installations of zero clearance fireplaces are common, due to poor connections between components, failure to provide insulation where required, provision of insulation where none is allowed, and/or failure to maintain the needed clearance from combustibles (even zero-clearance fireplaces require clearance from some surfaces). As mentioned earlier, it is often difficult to see these problems once the system has been installed. The absence of a hearth in front of the fireplace is a common problem with these systems. Other hearth problems include undersized or poorly installed hearth systems.

Ash Dumps

Fireplaces with ash dumps should have covers. If the cover is missing, hot embers may accumulate in the ash pit. The pit is not intended to be a fireplace and combustible materials near the pit could be ignited. It is not an expensive undertaking to replace the cover.

Shared Flues

A fireplace cannot share a chimney flue with any other appliance, including another fireplace. Some older houses were built with shared flues, and it is strongly recommended that in these cases, one of the two appliances be abandoned. A specialist should be consulted to investigate the arrangement and recommend the most inexpensive corrective action. Possible solutions include closing off a second floor fireplace which is not used regularly, replacing the heating system with one which does not require a chimney connection (an electric furnace or a high efficiency gas furnace, for example), or providing a new chimney for one of the appliances.

This situation exists in many attached houses, where back-to-back fireplaces share a chimney flue. This can be an awkward arrangement to detect initially, and to resolve amicably. Another place where this arrangement is commonly seen includes a furnace in the basement, a fireplace in the living room directly above, and a second floor parlor fireplace directly above the living room. Often the chimney will have two flues, despite the presence of three appliances. From a simple visual inspection, it cannot be determined which two appliances share a flue.

The amount of flexibility one has may be limited because heating systems typically have smaller flues than fireplaces. Relocating or changing the heating system may not allow connection of a fireplace into a small flue. Professional advice is required in a situation like this.

Facade Movement

A common problem on modern fireplaces is a masonry facade pulling away from the wall itself. This usually takes the form of rotation of the mantle in towards the room, with the greatest amount of movement at the top. The cause is usually a floor system too weak to carry the weight of the concentrated masonry load without sagging. In most cases, the problem is not serious, but where the tightness of the firebox is compromised, repairs are necessary. Repairs typically include resupporting from below.

► 9.0 PARTY WALLS

Introduction: Party walls or common walls separate two different homes in the same building.

Masonry: Masonry party walls provide relatively good fire protection between the two houses, although very little in the way of acoustic insulation.

Wood-frame: Wood-frame partition walls provide less fire protection, although if properly installed and insulated, can be better from an acoustic standpoint. A great many walls are masonry part of the way up through the house, and wood-frame in the attic.

None in Attic: In some attached houses, there is no wall between the attic areas. This openly communicating space is a less desirable situation in terms of fire protection, of course, than a masonry wall right up to the underside of the roof. Modern construction codes do not permit this arrangement.

► 10.0 BASEMENT LEAKAGE - INTRODUCTION

Basement leakage is the most common problem found in houses; 98% of all basements will leak at some point during their life. While structural damage caused by leakage is very rare, water in the basement can be a major inconvenience and often causes damage to interior finishes and storage. In addition, odors caused by mold, mildew, and lack of ventilation are particularly offensive to some people.

Unfortunately, wet basements cannot be assessed for their severity, frequency, and inconvenience factor during a one time visit. There may or may not be clues that indicate a history of basement dampness. Even if visible, the clues usually do not give an indication of the severity or frequency.

Section 10.1 lists some of the clues that indicate basement dampness. However, the clues are usually inconclusive and can sometimes be misleading. For example, efflorescence forms on basement walls as water migrates through and evaporates, leaving minerals behind. Most people assume that the greater the efflorescence, the more severe the problem. In reality, the drier the air in the basement, the greater the rate of evaporation and hence, the greater the mineral deposits. Therefore, the amount of efflorescence can be increased simply by using a de-humidifier.

Rust, mold and mildew can be caused by moisture penetration into the basement, but can also be caused by condensation forming on foundation walls as hot, humid summer air comes in contact with the cool walls.

Moisture problems are also intermittent. In some houses, water penetration will occur after virtually every rain. In other houses, it will occur only after periods of prolonged rain, and in still others, it will only happen with wind driven rain or during a spring thaw. In most cases however, the resultant damage gives no indication of frequency.

10.1 Identification of Problems

Wall Repairs

A. Repairs noted on the interior and exterior which may suggest wet basement problems include patching with bituminous materials, cement parging, or anyone of a myriad of waterproofing products. On the exterior, freshly excavated areas may also indicate moisture problem repairs. New sod along the edge of a house would similarly be an indication that exterior water control work may have been undertaken.

Efflorescence

B. Efflorescence is a whitish mineral deposit often seen on the interior of foundation walls. The presence of efflorescence indicates moisture penetration, although it does not tell a great deal about the severity of the problem or whether the problem is active. As water passes through the wall, it dissolves salts in the masonry, concrete or mortar, so that when the water arrives at the wall surface, it contains a good deal of minerals in solution. The crystalline salt deposit, known as efflorescence, is left as water is evaporated off the wall surface. This may be the result of outside water passing through the wall, or water rising up through the wall by capillary action.

Rust

C. Rusty nails in baseboards or paneling, rusted electrical outlet boxes or rusted metal feet on appliances may indicate wet basement problems.

Mildew Stains, Etc.

D. Other indicators include mildew; water stains; sagging cardboard boxes stored on the floor; crumbling plaster or drywall; lifting floor tiles; rotted or discolored wood at or near floor level; storage on skids or boards raised off the floor; dehumidifiers; peeling paint; crumbling concrete.

Lowered Basement Floors

E. When basements are lowered, the exterior drainage tile becomes largely ineffective, because it ends up above the floor level. Houses with lowered basements are much more prone to leaking basement problems. This is anticipated in some cases, and interior drainage tile may be provided below the new basement floor. More information may be found in the “Lowering Basement Floors” discussion in Section 2.0 of the Structure chapter.

Water Source

When a wet basement problem is identified, it should be determined that the source is not from within the house. A leaking plumbing system, water heater, washing machine, or hot water heating system, may all be confused with basement leakage. Sewers may back up through floor drains, causing basement flooding. During the summer months, condensation on cold water piping can make a localized section of a basement surprisingly wet. Condensation on cool foundation walls can also be mistaken for leakage. This often results in a damp basement odor. These sources obviously require specific and appropriate corrective action.

10.2 Approach: As explained in the Introduction, basement leakage clues, or lack thereof, are not a good indication of the severity or frequency of the leakage problems. Since virtually all basements leak at some point, the question is probably not, “Will the basement leak?” but, “When?”.

If one is willing to invest some time and effort, most wet basement problems can be cured or significantly reduced, relatively inexpensively. The dilemma is that some cannot.

Most contractors hired to solve wet basement problems are not prepared to bear this responsibility. They do not want to suggest solutions that usually work, but sometimes don’t, even if those suggestions would result in significant savings for the home owner. Therefore, many contractors offer solutions which reduce their likelihood of receiving call-backs. Unfortunately, these solutions tend to be the most disruptive and expensive.

If one cannot afford to experiment (because, for example, the basement is going to be rented out, or is about to be finished), the higher cost but lower risk approach makes sense. However, a less radical and more systematic approach will usually yield a far less expensive solution.

Less than 10% of basement leakage problems are caused by ground water (underground streams and high water tables). Since more than 90% of wet basement problems are caused by surface water (rain or snow) collecting around the building, the surface water issues should be addressed first.

Rather than providing a barrier to water penetration and a collection system for the water, it makes sense to make the water flow away from the building. Even houses with porous foundation walls and no drainage tiles will not leak if the surface water flows away from the house and is not allowed to saturate the soil around the building.

The same philosophy holds true with the water that runs off roof surfaces. If it can be collected and discharged away from the house, it will not contribute to basement dampness.

Once the source of the water has been reduced as much as possible, attention should be directed towards localized cracks and holes in foundation walls which provide little resistance to water penetration. Large scale digging, dampproofing and the installation of drainage tiles should only be contemplated after improving gutters and downspouts, grading, and obvious points of penetration.

The remainder of this chapter deals with these repairs in order of priority. If the steps are taken systematically, most basement dampness problems can be cured or significantly reduced, relatively inexpensively.

10.3 Gutters and Downspouts: Eliminating or minimizing the source of the water is very important with respect to keeping any basement dry. The gutters and downspouts must be complete and free from leakage or overflowing. Downspouts must be well connected and continuous. The downspouts should either discharge into a waste plumbing system below ground, or above grade at least six feet away from the building, depending on land slope, soil porosity, etc.

It is common for downspouts which discharge into an underground waste plumbing system to become obstructed or broken below grade level. This can lead to a large concentration of water just outside the foundation wall which almost inevitably results in leakage. Excavating and repairing or replacing this section of piping is expensive. Often, rearranging the downspout to discharge above grade several feet from the building is a less expensive and equally satisfactory alternative. Where above grade discharge is not practical, the underground drainage system must be repaired.

Localized low areas including basement stairwells, window wells, et cetera, may allow water to collect. Drains should be provided in the bottom of these, and the drain should be kept clear of debris. If necessary, these openings can be covered to prevent water accumulation. There are clear plastic dome covers, for example, available for basement window wells. These do allow light into the basement, although, of course, ventilation is cut off. Grading around window wells is critical.

10.4 Grading Improvements: Regrading the exterior to drain water away from the building rather than toward it is one of the most effective solutions to wet basement problems. Ideally, the ground should slope down away from the house at a rate of one inch per foot for the first six feet. Impervious surfaces like asphalt driveways can slope less, with almost any positive slope being effective.

This work can be expensive where driveways, patios or sidewalks have to be lifted, although in lawn and garden areas, adding some inexpensive topsoil is all that is required. Gravel is not a good material to use, since water will flow through this easily. Well compacted soils which force most of the water to run across the surface are preferred.

Even when basement leakage is not an active problem, good drainage should be ensured during any landscaping or driveway work. Where good grading cannot be achieved, catch basins should be used. Water should be directed toward the basins which should carry water to a drainage system. Catch basins are prone to clogging and frost heaving. Good maintenance is necessary to ensure a dry basement.

Where the grading problem is initiated by a neighboring property, the local building authorities can be of assistance in resolving any problem. City building departments are generally aware of the importance of good grading.

Where drainage cannot be away from the building for six feet or so (because of a neighbor's house, for example) the best compromise is a low area between two buildings which directs water along a trough to a point away from both buildings. If this is not possible, a catch basin may be necessary.

Poor grading is a common problem on newer houses. The backfill around new houses is often not well compacted (for fear of damaging new foundation walls). Over the first few years, the soil will settle, and the grading may have to be improved.

From Inside

10.5 Patching Cracks: Cracks in poured concrete basement walls can sometimes be successfully repaired from the inside. There are several products available to the homeowner in the hardware and building supply stores. Some require the crack to be dry, while others can be applied to wet walls. For these products, it is generally best to widen out the crack into a "V" shape to allow the patching material to bond to the wall.

Epoxy and Polyurethane

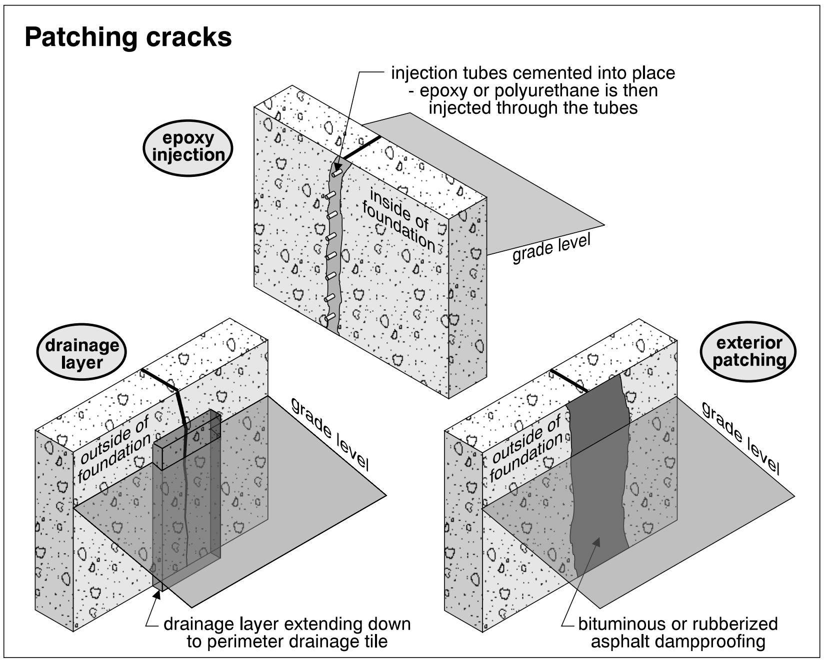
Epoxy is usually installed by a contractor and is considered by some to be the best patch material for poured concrete walls. It is, however, only as good as the person who mixes and installs it. Epoxy is different than most patching materials in that it does have structural integrity. A properly installed epoxy patch will never crack again. The wall will fail elsewhere first. If the forces that caused the crack are still present, a crack parallel to the original crack will reform. For this reason, some contractors prefer polyurethane injection, as it stays flexible.

For Minor Problems Only

It should be understood that patching cracks does not remove the water problem; it only traps it outside the basement. Patching cracks is usually only successful. for minor problems. In many cases, the water will simply find another way in. It is better to prevent water accumulation outside the basement, rather than to try to make a boat out of the basement. The big appeal of patching cracks inside the basement is that it is inexpensive. Interior patching is very seldom effective for hollow block walls.

Outside Patching Better

Patching from the outside is more expensive, but more often successful. Covering a patch with a good draining material, such as glass fiber insulation board designed for below grade use, will help protect the patch and keep water away. If the basement is only wet in areas adjacent to obvious cracks, patching may be a practical approach.



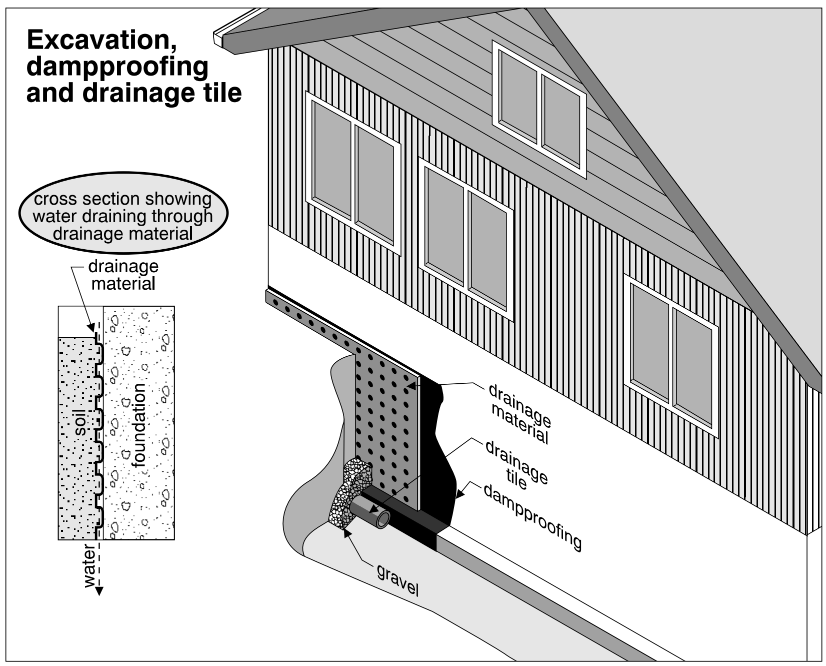
10.6 Excavation, Dampproofing and Drainage Tile:

When basement leakage cannot be eliminated or minimized by controlling the surface water or by patching, more extensive measures are required.

At this point, it is necessary to excavate on the building exterior, to dampproof the outside walls, and to provide or replace the perimeter drainage tile system.

Drainage Tile Perimeter drainage tile systems, sometimes incorrectly called weeping tiles, were introduced to residential construction after the first World War. They did not become popular until some time after this. On an older house, even if they are present, they are often obstructed. This drainage tile system was traditionally a four inch clay tile pipe. The piping was laid outside the footing around the perimeter of the house, below the basement floor level. Individual sections of pipe were not connected, with roughly a 1/4 inch space left between each section of pipe. This allowed water to run into the piping if the soil in this area was saturated. The joints were covered at the top with building paper to prevent soil and other debris from getting into the piping system.

This approach was somewhat effective, although over the long term tree roots and debris inevitably found their way into the pipe. The pipes were usually surrounded and covered with gravel to allow water to penetrate quickly to the pipes and be carried away. In older homes, the piping system would discharge into the combination sewer.



In modern construction, the piping used is perforated plastic, and it is arranged to discharge straight into a storm sewer. The perforated plastic piping which has replaced the clay tile piping is corrugated and very flexible. The perforations are in half of the diameter of the pipe only. The piping should be laid with the holes down.

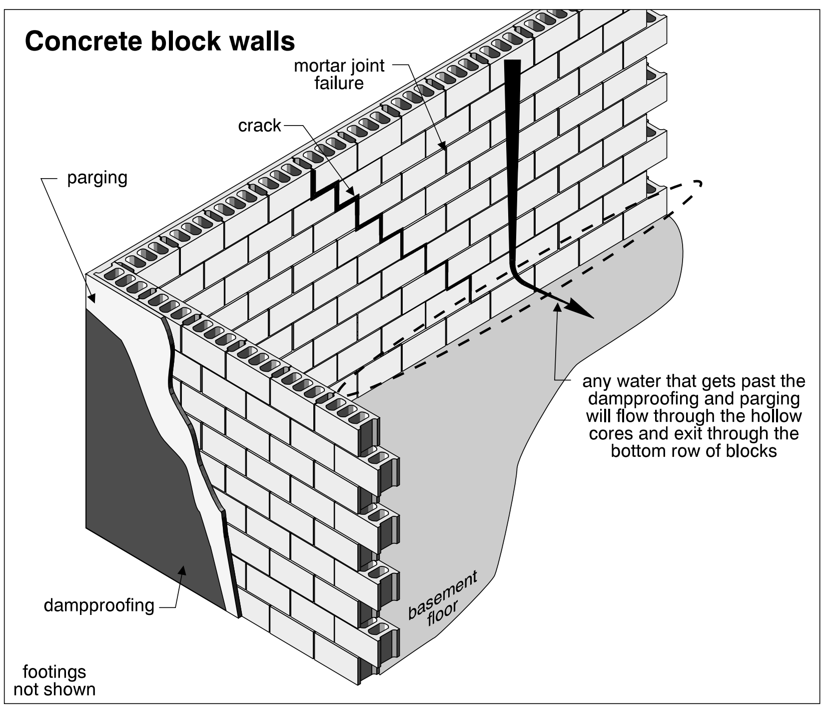
Often only one or two walls of the basement have to be excavated and so treated, although in severe cases, the entire perimeter must be addressed.

The drainage tile should be laid so that the top of the tile is below the bottom of the floor slab. The drainage tile should be surrounded at the top and sides with at least six inches of gravel or crushed stone. Filter paper above and below the tile will help prevent clogging.

The drainage system should discharge into a storm sewer where possible. Where no sewer is available, the drainage can be above grade well away from the house, if the natural slope allows a gravity flow down to such a point. Where dry wells are permitted, the foundation drain can discharge into a dry well. This is a gravel pit, typically located below the foundation drainage system, at least fifteen feet from the building. This is also called a french drain, and is only suitable where soil conditions will allow drainage out of the well. The water table, of course, must be below the bottom of a dry well.

Where none of these approaches is possible, the foundation drain system must go inside to a sump, and the water is pumped up and out, into a sewer system or a good distance away from the house.

Dampproofing The dampproofing on the exterior typically involves parging the wall with a one-quarter inch layer of mortar which ideally extends down to the footing. (Parging is not required on poured concrete.) The foundation/footing joint is coved to improve the seal and direct the water into the drainage tile. Next, a dampproofing coat which may be bituminous or plastic, is applied to the wall.



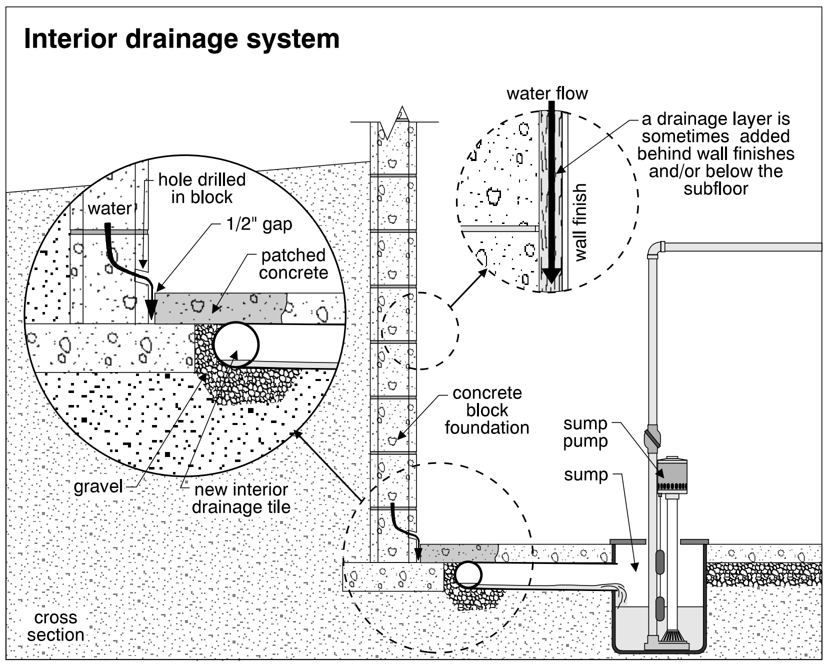
Exterior Basement Insulation

Many experts recommend exterior basement insulation. Rigid glass fiber insulation board designed for use below grade provides good insulation and helps keep the basement dry. Water entering the insulation flows quickly down through it to the drainage tile.

Drainage Layer

As an alternative, a drain layer/membrane can be placed against the exterior walls below grade to allow water to flow freely to the drainage tile.

10.7 Interior Drainage Systems: Because excavating on the exterior is expensive, and almost always leads to disruption of patios, driveways, and landscaping, a less expensive alternative is sometimes employed from the building interior. A roughly ten inch wide strip of the concrete floor is broken up around the inside of the foundation wall. A drainage tile system is installed below the basement floor inside the footings. The water can then be run into a waste sewer system, if gravity permits, or a sump.



This approach is somewhat less desirable than the exterior approach, since water has no natural inclination to find this drainage tile. Water may accumulate on the outside of the foundations for some time and may leak through the exterior walls before it is carried away by this drainage system on the inside. The water, of course, must pass through the foundation or footing system, or go under the footing to reach this tile. In rare cases, this can undermine the footings.

Also, with no exterior excavation, dampproofing or waterproofing the outside of the foundation wall is not possible. In some cases, holes are drilled through the foundation wall just above the footing to allow water to drain into this tile system.

Incidentally, the tile is typically surrounded by gravel. The cost of this approach is typically one third to one quarter of the cost of exterior work, depending on the difficulties encountered on the outside. There are many cases where this proves satisfactory, although on a case by case basis, it is very difficult to know whether it will work.

10.8 Ground Water Problems: In the very few cases where the problem is ground water rather than surface water, more extensive solutions are required. Normally, houses are not built below the water table. However, the water table may rise intermittently in areas with heavy seasonal rainfall. Changes in neighborhoods as development increases, for example, may lead to changes in the natural water table.

Where the basement floor is below the water table, water constantly pouring into the basement will often be experienced. A drainage tile system and a sophisticated pumping system, perhaps employing dual pumps, is often used. Since the water is constantly present, and pumps are susceptible to either mechanical or electrical failure, a house with this arrangement is always vulnerable to wet basement problems.

Where the presence of water in the soil impairs the ability of the soil to carry a foundation for a new home, a mat or raft foundation may be built. These are one piece heavily reinforced concrete floating foundations. Another option is to build on piles driven deep into the ground. Please refer to the Structure chapter.

Where the water table is higher than a normal basement floor, building without a basement or with only a shallow crawl space is desirable.

10.9 Basement Floor Leakage: Water leakage up through a basement floor slab is usually a result of saturated soil in and around the foundation. This is often accompanied by leakage through the foundation walls, or through the intersection of the foundation wall and the basement floor slab. In severe cases, the hydrostatic pressure can cause the floor slab to heave, although this is more often a result of frost when the house is left unheated during winter.

The corrective actions for basement wall leakage are also appropriate for water penetration through a floor slab. Ideally, the source of the water is eliminated. If this is not possible, the water has to be controlled and diverted to a sump. Original basement floors which were very thin (one inch or less, for example) are sometimes broken up so badly that they are replaced. Gravel fill, four to six inches thick, is usually added before the new slab is poured, and a waterproof membrane (often plastic) may be laid under the new floor. The new floor thickness is ideally three inches, although often the basement headroom in old houses is so restricted that losing another three inches of height is a big sacrifice. As a result, the concrete floor is often thinner.

10.10 Summary: Once the problem is identified as exterior water penetration, the corrective action process would be a step by step approach as follows. First, provide or improve gutters and downspouts as necessary. Second, reslope exterior grading to provide natural drainage of water away from the building. Third, patch any obvious cracks or gaps from the interior. Fourth, excavate and patch the foundations where leakage is localized. While this is being done, it makes sense to see whether perimeter drainage tile is in place and, if so, to determine its condition. A plumber's snake can be fed through the tile to ensure it is clear.

The next step would be to engage a professional to comment on whether an interior drainage tile system below the basement floor may be appropriate, or whether excavation, dampproofing and an outside foundation drainage tile system is appropriate.

The exterior excavation, dampproofing and perimeter drainage tile system may also require the addition of a sump and pump, depending on local drainage characteristics.

If chronic flooding is a problem, it may be wise to contact the city and neighbors to see whether the problem is area wide, or specific to one house. Where the problem is a neighborhood situation, the city will often make efforts to improve surface drainage or to control storm water.

City officials and neighbors can often advise whether the problem is related to surface water or ground water. Areas of high water tables are often well known to the city authorities. (High water table areas, of course, make it difficult for utility people to lay water supply and sewer lines below grade level.)

People offering quick and easy solutions to wet basement problems are to be approached with some skepticism. Some companies utilize an injection process around the house wherein an expandable material such as bentonite clay is used in an effort to fill the voids in the soil around the foundations and prevent water accumulation. Generally speaking, this is not an effective long term solution and, in some cases, there is no noticeable improvement.

By the same token, people jumping to the conclusion that the solution is always expensive and always requires digging, should also be approached with some skepticism.

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