Contents

Chapter 6—Housing Structure

"The Palace of Fine Arts in Mexico City has sunk more than 10 feet into the ground since it was built 60 years ago and the most noticeable effect is that the grand stone stairway has disappeared and the entrance is now at street level."

C.B. Crawford,
Canadian Building Digest

Introduction

The principal function of a house is to provide protection from the elements. Our present society, however, requires that a home provide not only shelter, but also privacy, safety, and reasonable protection of our physical and mental health. A living facility that fails to offer these essentials through adequately designed and properly maintained interiors and exteriors cannot be termed "healthful housing."

In this chapter, the home is considered in terms of the parts that have a bearing on its soundness, state of repair, and safety. These are some of the elements that the housing inspector must examine when making a thorough housing inspection.

Figure 6.1 shows a typical house being built and inspected today and includes a terminology key. Both the figure and the key are available in an interactive format in the glossary on the U.S. Inspect Web site [1].

Figure 6.2 shows a typical house built between 1950 and 1980 and also includes a terminology key. The figures show the complexity and the numerous components of a home. These components form the vocabulary that is necessary to discuss housing structure inspection issues.

Key to Figure 6.1 (New Housing Terminology)

1. **Ash dump** (see 35)—A door or opening in the firebox that leads directly to the ash pit, through which the ashes are swept after the fire is burned out. All fireboxes are not equipped with an ash dump.

2. **Attic space**—The open space within the attic area.

3. **Backfill**—The material used to refill an excavation around the outside of a foundation wall or pipe trench.

4. **Baluster**—One of a series of small pillars that is

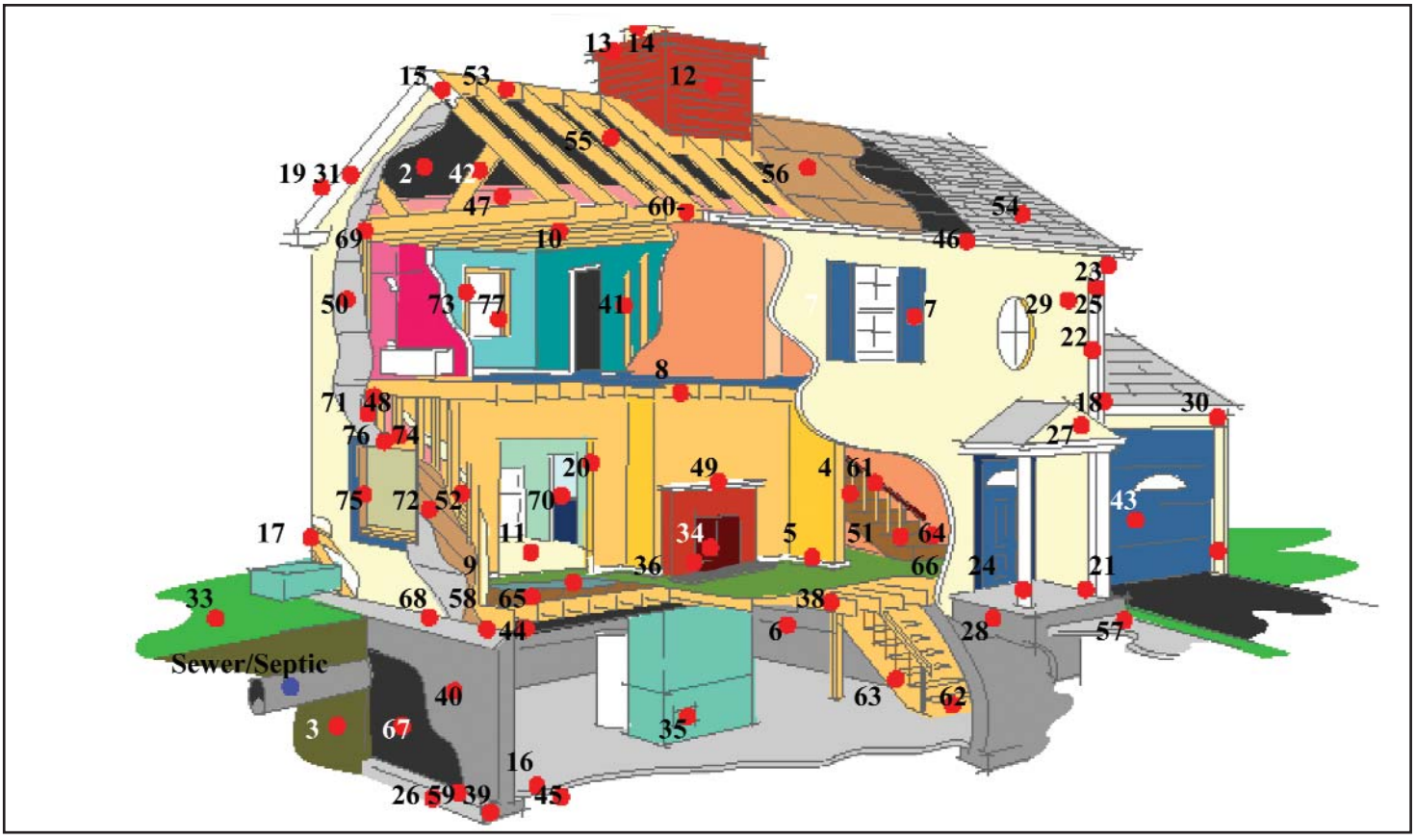

Figure 6.1. Housing Structure Terminology, Typical House Being Built Today [1]

attached to and runs between the stairs and the handrails. The spacing between the balusters should be less than 4 inches to prevent small children from getting stuck between the balusters. Balusters are considered a safety item and provide an additional barrier.

5. **Baseboard trim**—Typically a wood trim board that is placed against the wall around the perimeter of a room next to the floor. The intent is to conceal the joint between the floor and wall finish.

6. **Basement window**—A window opening installed in the basement wall. Basement windows are occasionally below the finish grade level and will be surrounded on the exterior by a window well.

7. **Blind or shutter**—A lightweight frame in the form of a door located on each side of a window. They are most commonly constructed of wood (solid or louvered panels) or plastic. Originally they were designed to close and secure over the windows for security and foul weather. Most shutters now are more likely decorative pieces that are secured to the house beside the windows.

8. **Bridging**—Small pieces of wood or metal strapping placed in an X-pattern between the floor joists at midspan to prevent the joists from twisting and squeaking and to provide reinforcement and distribution of stress.

9. **Building paper/underlayment**—Building material, usually a felt paper that is used as a protective barrier against air and moisture passage from the area beneath the flooring as well as providing a movement/noise isolator in hardwood flooring.

10. **Ceiling joist**—A horizontally placed framing members at the ceiling of the top-most living space of a house that provides a platform to which the finished ceiling material can be attached.

11. **Chair rail (not shown)**—Decorative trim applied around the perimeter of a room such as a formal dining room or kitchen/breakfast nook at the approximate same height as the back of a chair. It is sometimes used as a cap trim for wainscoting (see *wainscoting*).

12. **Chimney**—A masonry or in more modern construction wood framed enclosure that surrounds and contains one or more flues and extends above the roofline.

13. **Chimney cap**—The metal or masonry protective coveringat the top of the chimney that seals the chimney shaft from water entry between the chimney enclosure and the flue tiles.

14. **Chimney flues**—The space or channel in a chimney that carries off the smoke and other combustion gases to the outside air. Most homes will have a terra cotta tile flue or a metal flue.

15. **Collar beam/tie**—A horizontal piece of framing lumber that provides intermediate support for opposite rafters. They are usually located in the middle to upper third portion of the rafters. It is also known as a collar beam or collar brace.

16. **Concrete slab floor**—Typically approximately 4 inches thick, the concrete slab floor provides a number of uses. It creates a solid level surface to walk and work on. It provides a separation between the grade/soil and a potentially livable area. It also provides lateral compression resistance for the foundation walls, preventing soil pressure from outside the foundation from pushing the foundation walls and footings inward.

17. **Corner brace**—Diagonal braces placed at the corners of framed walls to stiffen them and provide extra strength.

18. **Cornice**—An overhang of a pitched roof at the eave line that usually consists of a fascia board, a soffit, and any appropriate moldings or vents.

19. **Cornice molding**—The individual pieces of wood trim that are applied to the cornice area at the eaves.

20. **Door casing/trim**—The finish trim details around the perimeter of the door on the interior finished wall.

21. **Door frame/jamb**—The top and sides of the door to include the wall framing as well as the actual door frame and trim.

22. **Downspout**—A pipe, usually of metal or vinyl, that is connected to the gutters and is used to carry the roof-water runoff down and away from the house.

23. **Downspout gooseneck**—Segmented section of downspout that is bent at a radius to allow the

downspout to be attached to the house and to follow the bends and curves of the eaves and ground.

24. **Downspout shoe**—The bottom downspout gooseneck that directs the water from the downspout to the extension or splash block at the grade.

25. **Downspout strap**—Strap used to secure the downspout to the side of the house.

26. **Drain tile**—A tube or cylinder that is normally installed around the exterior perimeter of the foundation footings that collects and directs ground water away from the foundation of the house. The tile can be individual sections of clay or asphalt tubing or, in more recent construction, a perforated-plastic drain tile that is approximately 4 inches in diameter. The drain tile leads either towards a sump or to an exterior discharge away from the house.

27. **Entrance canopy**—A small overhanging roof that shelters the front entrance.

28. **Entrance stoop**—An elevated platform constructed of wood framing or masonry at the front entry that allows visitors to stand above or out of the elements. The platform should be wide enough to allow someone to stand on the platform while opening an outward swinging door such as a storm door even if one is not present.

29. **Exterior siding**—The decorative exterior finish on a house. Its primary function is to protect the shell of the house from the elements. The choice of siding materials varies widely to include wood, brick, metal, vinyl, concrete, stucco, and a variety of manufactured compositions such as compressed wood, compressed cellulose (paper), fiber-reinforced cement, and synthetic stucco.

30. **Fascia**—The visible flat front board that caps the rafter tail ends and encloses the overhang under the eave that runs along the roof edge. The gutter is usually attached at this location.

31. **Fascia/rake board**—The visible flat front board that caps the rafter tail ends and encloses the overhang under the eave that runs along the roof edge and at the edge of the roofing at the gables. The gutter is usually attached to this board at the eaves.

32. **Finish flooring** (not shown)—The final floor covering inside the living space of a house. The most common types of finishes are carpeting; hardwood flooring; ceramic, composite, or laminate stone tile; parquet panels; or vinyl sheet flooring.

33. **Finished grade line**—A predetermined line indicating the proposed elevation of the ground surface around a building.

34. **Firebox**—The cavity in the open face of the fireplace in which the fire is maintained. The firebox leads directly to the fireplace flue. The firebox is constructed of fire or refractory brick set in fireclay or reinforced mortar in traditional masonry fireplaces. The firebox may also be constructed of metal or ceramic-coated metal panels in more modern prefabricated fireplaces. The walls of the firebox are usually slanted toward the living space both to direct smoke up toward the flue and to reflect heat into the room.

35. **Fireplace cleanout door**—The access door to the ash pit beneath the fireplace. On a fireplace that is located inside the house, the cleanout door is usually located in the lowest accessible level of the house such as the basement or crawl space. On a fireplace that is located at the outside of the house, the cleanout door will be located at the exterior of the chimney. Not all fireplaces are equipped with a cleanout door.

36. **Fireplace hearth**—The inner or outer floor of a fireplace, usually made of brick, tile, or stone.

37. **Flashing** (not shown)—The building component used to connect and cover portions of a deck, roof, or siding material to another surface such as a wall, a chimney, a vent pipe, or anywhere that runoff is heavy or where two dissimilar materials meet. The flashing is mainly intended to prevent water entry and is usually made of rubber, tar, asphalt, or various metals.

38. **Floor joists**—The main subfloor framing members that support the floor span. Joists are usually made of engineered wood I-beams or 2×8 or larger lumber.

39. **Foundation footing**—The base on which the foundation walls rests. The foundation is wider than the foundation wall to spread out the load it is bearing and to help prevent settling.

40. **Foundation wall**—The concrete block, concrete slab or other nonwood material that extends below or

partly below grade, which provides support for exterior walls and other structural pans of the building.

41. **Framing studs**—A 2×4 or 2×6 vertical framing member used to construct walls and partitions, usually spaced 12 to 24 inches apart.

42. **Gable framing**—The vertical and horizontal framing members that make up and support the end of a building as distinguished from the front or rear side. A gable is the triangular end of an exterior wall above the eaves.

43. **Garage door**—The door for the vehicle passage into the garage area. Typical garage doors consist of multiple jointed panels of wood, metal, or fiberglass.

44. **Girder**—A large beam supporting floor joists at the same level as the sills. A larger or principal beam used to support concentrated loads at isolated points along its length.

45. **Gravel fill**—A bed of coarse rock fragments or pebbles that is laid atop the existing soil before pouring the concrete slab. The gravel serves a dual purpose of breaking surface tension on the concrete slab and providing a layer that interrupts capillary action of subsurface moisture from reaching the concrete slab. Typically, a polyethylene sheeting will be installed between the gravel fill and the concrete slab for further moisture proofing.

46. **Gutter**—A channel used for carrying water run-off. Usually located at the eaves of a house and connected to a downspout. The primary purpose of the gutters and downspouts is to carry roof water run-off as far away from the house as possible.

47. **Insulation**—A manufactured or natural material that resists heat flow that is installed in a house's shell to keep the heat in a house in the winter and the coolness in the house in the summer. The most common form of insulation is fiberglass, whether in batts or blown-in material, along with cellulose, rigid foam boards, sprayed-in foam, and rock wool.

48. **Jack/king stud**—The framing stud, sometimes called the trimmer, that supports the header above a window, door, or other opening within a bearing wall. Depending on the size of the opening, there may be several jack studs on either side of the opening.

49. **Mantel**—The ornamental or decorative facing around a fireplace including a shelf that is attached to the breast or backing wall above the fireplace.

50. **Moisture/vapor barrier**—A nonporous material, such as plastic or polyethylene sheeting, that is used to retard the movement of water vapor into walls and attics and prevent condensation in them. A vapor barrier is also installed in crawl space areas to prevent moisture vapor from entering up through the ground.

51. **Newel post**—The post at the top and bottom of the handrails and anywhere along the stair run that creates a directional change in the handrails is called the newel post. The newel post is securely anchored into the underlying floor framing or the stair stringer to provide stability to the handrails.

52. **Reinforcing lath**—A strip of wood or metal attached to studs and used as a foundation for plastering, slating or tiling. Lath has been replaced by gypsum board in most modern construction.

53. **Ridge board/beam**—The board placed on edge at the top-most point of the roof framing, into which the upper ends of the rafters are joined or attached.

54. **Roofing**—The finished surface at the top of the house that must be able to withstand the effects of the elements (i.e., wind, rain, snow, hail, etc.). A wide variety of materials are available, including asphalt shingles, wood shakes, metal roofing, ceramic and concrete tiles, and slate, with asphalt shingles making up the bulk of the material used.

55. **Roof rafters**—Inclined structural framing members that support the roof, running from the exterior wall the to the ridge beam. Rafters directly support the roof sheathing and create the angle or slope of the roof.

56. **Roof sheathing**—The material used to cover the outside surface of the roof framing to provide lateral and rack support to the roof, as well as to provide a nailing surface for the roofing material. This material most commonly consists of plywood OSB or horizontally laid wood boards.

57. **Sidewalk**—A walkway that provides a direct, all-weather approach to an entry. The sidewalk can be constructed of poured concrete, laid stone, concrete pavers, or gravel contained between borders or curbs.

58. **Sill plate**—The horizontal wood member that is anchored to the foundation masonry to provide a nailing surface for floors or walls built above.

59. **Silt fabric**—A porous fabric that acts as a barrier between the backfilled soil (see *backfill*) and the gravel surrounding the drain tile. This barrier prevents soil particles from blocking the movement of groundwater to the drain tile.

60. **Soffit/lookout block**—Rake cross-bracing between the fly rafters and end gable rafters that the soffit is nailed to.

61. **Stair rail**—A sturdy handhold and barrier that follows the outside, and sometimes inside, perimeter of the stairs. The stair rail is used to prevent falls and to provide a means of additional support when walking up or down the stairs.

62. **Stair riser**—The vertical boards that close the space between each stair tread on a set of stairs (see *stair stringer* and *stair tread*).

63. **Stair stringer**—The supporting members in a set of stairs that are cut or notched to accept the individual treads and risers (see *stair riser* and *stair tread*).

64. **Stair tread**—The horizontal board in a stairway that is walked upon (see *stair riser* and *stair stringer*).

65. **Subfloor**—Boards or plywood, installed over joists, on which the finish floor rests.

66. **Support post**—A vertical framing member usually designed to carry or support a beam or girder. In newer construction a metal lally (pronounced "lolly") column is commonly used, as well as 4×4- or 6×6-inch wood posts.

67. **Tar**—Otherwise known as asphalt, tar is a very thick, dark brown/black substance that is used as a sealant or waterproofing agent. It is usually produced naturally by the breakdown of animal and vegetable matter that has been buried and compressed deep underground. Tar is also manufactured—a hydrocarbon by-product or residue that is left over after the distillation of petroleum. It is commonly used as a sealant or patch for roof penetrations, such as plumbing vents and chimney flashing. Tar is also used as a sealer on concrete and masonry foundation walls before they have been backfilled.

68. **Termite shield**—A metal flashing that is installed below the sill plate that acts as a deterrent to keep termites from reaching the sill plate.

69. **Top plate**—The topmost horizontal framing members of a framed wall. Most construction practices require the top plate to be doubled in thickness.

70. **Wainscoting**—The wooden paneling of the lower part of an interior wall up to approximately waist-height or between 36 and 48 inches from the floor.

71. **Wall insulation**—A manufactured or natural material that resists heat flow that is installed in a house's shell to keep the heat in a house in the winter and the coolness in the house in the summer. Fiberglass batts are the most common form of wall insulation.

72. **Wall sheathing**—The material used to cover the outside surface of the wall framing that provides lateral and shear support to the wall as well as a nailing surface for the exterior siding.

73. **Window casing/trim**—The finish trim details around the perimeter of the window on the interior finished wall.

74. **Window cripple**—Short studs placed between the header and a top plate or between a sill and sole plate.

75. **Window frame/jamb**—The top and sides of the window, to include the wall framing and the actual window frame and trim.

76. **Window header**—A beam placed perpendicular to wall studs above doors, windows, or other openings to carry the weight of structural loads above the window or door.

77. **Window sash**—The framework that holds the glass in a door or window.

78. **Window well (not shown)**—An excavation around a basement window that prevents the surrounding soils from collapsing into the window. The window well surround is normally constructed of formed corrugated galvanized metal, built-up masonry, or pressure-treated wood.

Key to Figure 6.2 (Old Housing Terminology)

Fireplace

1. **Chimney**—A vertical masonry shaft of reinforced concrete or other approved noncombustible, heat resisting material enclosing one or more flues. It removes the products of combustion from solid, liquid or gaseous fuel.

2. **Flue liner**—The flue is the hole in the chimney. The liner, made of terra cotta or metal, protects the brick from harmful smoke gases.

3. **Chimney cap**—This top is generally of concrete. It protects the brick from weather.

4. **Chimney flashing**—Sheet metal flashing provides a tight joint between chimney and roof.

5. **Firebrick**—An ordinary brick cannot withstand the heat of direct fire, and so special firebrick is used to line the fireplace. In newer construction, fireplaces are constructed of prefabricated metal inserts.

6. **Ash dump**—A trap door to let the ashes drop to a pit below, where they may be easily removed.

7. **Cleanout door**—The door to the ash pit or the bottom of a chimney through which the chimney can be cleaned.

8. **Chimney breast**—The inside face or front of a fireplace chimney.

9. **Hearth**—The floor of a fireplace that extends into the room for safety purposes.

Roof

10. **Ridge**—The top intersection of two opposite adjoining roof surfaces.

11. **Ridge board**—The board that follows along under the ridge.

12. **Roof rafters**—The structural members that support the roof.

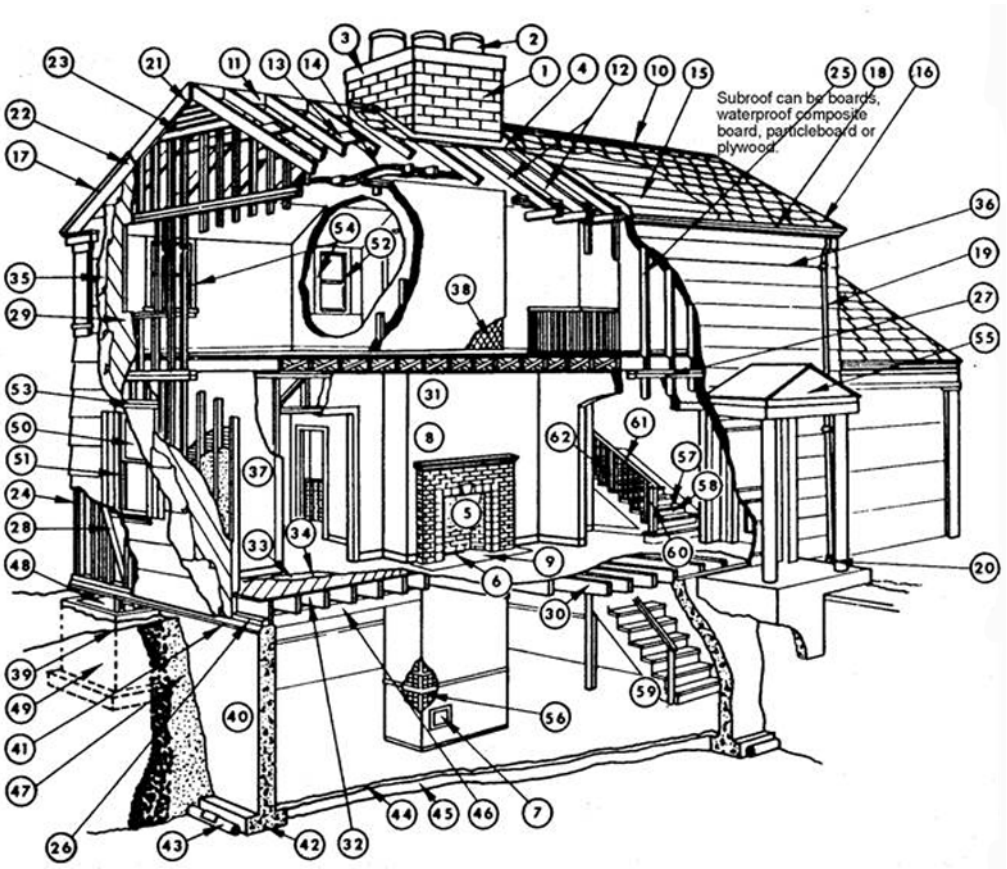

Figure 6.2. Housing Structure and Terminology, Typical House Built Between 1950 and 1980 [2]

13. **Collar beam**—Not a beam at all; this tie keeps the roof from spreading and connects similar rafters on opposite sides of the roof.

14. **Roof insulation**—An insulating material (usually rock wool or fiberglass) in a blanket form placed between the roof rafters to keep a house warm in the winter and cool in the summer.

15. **Roof sheathing**—The boards that provide the base for the finished roof. In newer construction, roof sheathing is composed of sheets of plywood, or oriented strand board (OSB).

16. **Roofing**—The wood, asphalt or asbestos shingles—or tile, slate, or metal—that form the outer protection against the weather.

17. **Cornice**—A decorative element made of molded members, usually placed at or near the top of an exterior or interior wall.

18. **Gutter**—The trough that gathers rainwater from a roof.

19. **Downspout**—The pipe that leads the water down from the gutter.

20. **Storm sewer tile**—The underground pipe that receives the water from the downspouts and carries it to the sewer. In newer construction, plastic-type material have replaced tile.

21. **Gable**—The triangular end of a building with a sloping roof.

22. **Barage board**—The fascia or board at the gable just under the edge of the roof.

23. **Louvers**—A series of slanted slots arranged to keep out rain, yet allow ventilation.

Walls and Floors

24. **Corner post**—The vertical member at the corner of the frame, made up to receive inner and outer covering materials.

25. **Studs**—The vertical wood members of the house, usually 2×4s at minimum and spaced every 16 inches.

26. **Sill**—The board that is laid first on the foundation, and on which the frame rests.

27. **Plate**—The board laid across the top ends of the studs to hold them even and tight.

28. **Corner bracing**—Diagonal strips to keep the frame square and plumb.

29. **Sheathing**—The first layer of outer wall covering nailed to the studs.

30. **Joist**—The structural members or beams that hold up the floor or ceiling, usually 2×10s or 2×12s spaced 16 inches apart.

31. **Bridging**—Cross-bridging or solid. Members at the middle or third points of joist spans to brace one to the next and to prevent them from twisting.

32. **Subflooring**—Typically plywood or particle wood that is laid over the joists.

33. **Flooring paper**—A felt paper laid on the rough floor to stop air infiltration and, to some extent, noise.

34. **Finish flooring**—Hardwood, of tongued and grooved strips, carpet, or vinyl products (tile, linoleum).

35. **Building paper or sheathing**—Paper or plasticized material placed outside the sheathing, not as a vapor barrier, but to prevent water and air from leaking in. Building paper is also used as a tarred felt under shingles or siding to keep out moisture or wind.

36. **Beveled siding**—Sometimes called clapboards, with a thick butt and a thin upper edge lapped to shed water. In newer construction, vinyl, aluminum, or fiber cement siding and stucco are more prevalent.

37. **Wall insulation**—A blanket of wool or reflective foil placed inside the walls.

38. **Metal lath**—A mesh made from sheet metal onto which plaster or other composite surfacing materials can be applied. In newer construction, plaster sheetrock 4-×8-foot sheets have replaced lath.

Foundation and Basement

39. **Finished grade line**—The top of the ground at the foundation.

40. **Foundation wall**—The wall of poured concrete (shown) or concrete blocks that rests on the footing and supports the remainder of the house.

41. **Termite shield**—A metal baffle to prevent termites from entering the frame.

42. **Footing**—The concrete pad that carries the entire weight of the house upon the earth.

43. **Footing drain tile**—A pipe with cracks at the joints, or perforated plastic pipe to allow underground water to drain away before it gets into the basement.

44. **Basement floor slab**—The 4- or 5-inch layer of concrete that forms the basement floor.

45. **Gravel fill**—Placed under the slab to allow drainage and to guard against a damp floor.

46. **Girder**—A main beam upon which floor joists rest. Usually of steel, but also of wood.

47. **Backfill**—Earth, once dug out, that has been replaced and tamped down around the foundation.

48. **Areaway**—An open space to allow light and air to a window. Also called a light well.

49. **Area wall**—The wall, of metal or concrete, that forms the open area.

Windows and Doors

50. **Window**—An opening in a building for admitting light and air. It usually has a pane or panes of glass and is set in a frame or sash that is generally movable for opening and shutting.

51. **Window frame**—The lining of the window opening.

52. **Window sash**—The inner frame, usually movable, that holds the glass.

53. **Lintel**—The structural beam over a window or door opening.

54. **Window casing**—The decorative strips surrounding a window opening on the inside.

Stairs and Entry

55. **Entrance canopy**—A roof extending over the entrance door.

56. **Furring**—Falsework or framework necessary to bring the outer surface level to the inner surface.

57. **Stair tread**—The horizontal part of a step that the foot hits when climbing up or down the stairs.

58. **Stair riser**—The vertical board connecting one tread to the next.

59. **Stair stringer**—The sloping board that supports the ends of the steps.

60. **Newel**—The post that terminates the railing.

61. **Stair rail—**The bar used for a handhold when using the stairs.

62. **Balusters—**Vertical rods or spindles supporting a rail.

Foundation

The word "foundation" is used to mean

- construction below grade, such as footings, cellar, or basement;
- the composition of the earth on which the building rests; and
- special construction, such as pilings and piers used to support the building.

The foundation bed may be composed of solid rock, sand, gravel, or unconsolidated sand or clay. Rock, sand, or gravel are the most reliable foundation materials. Figure 6.3 shows the three most common foundations for homes. Unconsolidated sand and clay, though found in many sections of the country, are not as desirable for foundations because they are subject to sliding and settling [1]. Capillary breaks have been identified as a key way of reducing moisture incursion in new construction [3].

The footing distributes the weight of the building over a sufficient area of ground to ensure that the foundation walls will stand properly. Footings are usually concrete; however, in the past, wood and stone have been used. Some older houses were constructed without footings.

Although it is usually difficult to determine the condition of a footing without excavating the foundation, a footing in a state of disrepair or lack of a footing will usually be indicated either by large cracks or by settlement in the foundation walls. This type of crack is called a "Z" crack.

Foundation wall cracks are usually diagonal, starting from the top, the bottom, or the end of the wall (Figure 6.4).

Cracks that do not extend to at least one edge of the wall may not be caused by foundation problems. Such wall cracks may be due to other structural problems and should also be reported.

The foundation walls support the weight of the structure and transfer this weight to the footings. The foundation walls may be made of stone, brick, concrete, or concrete blocks. The exterior should be moisture proofed with either a membrane of waterproof material or a coating of portland cement mortar. The membrane may consist of plastic sheeting or a sandwich of standard roofing felt joined and covered with tar or asphalt. The purpose of waterproofing the foundation and walls is to prevent water from penetrating the wall material and leaving the basement or cellar walls damp.

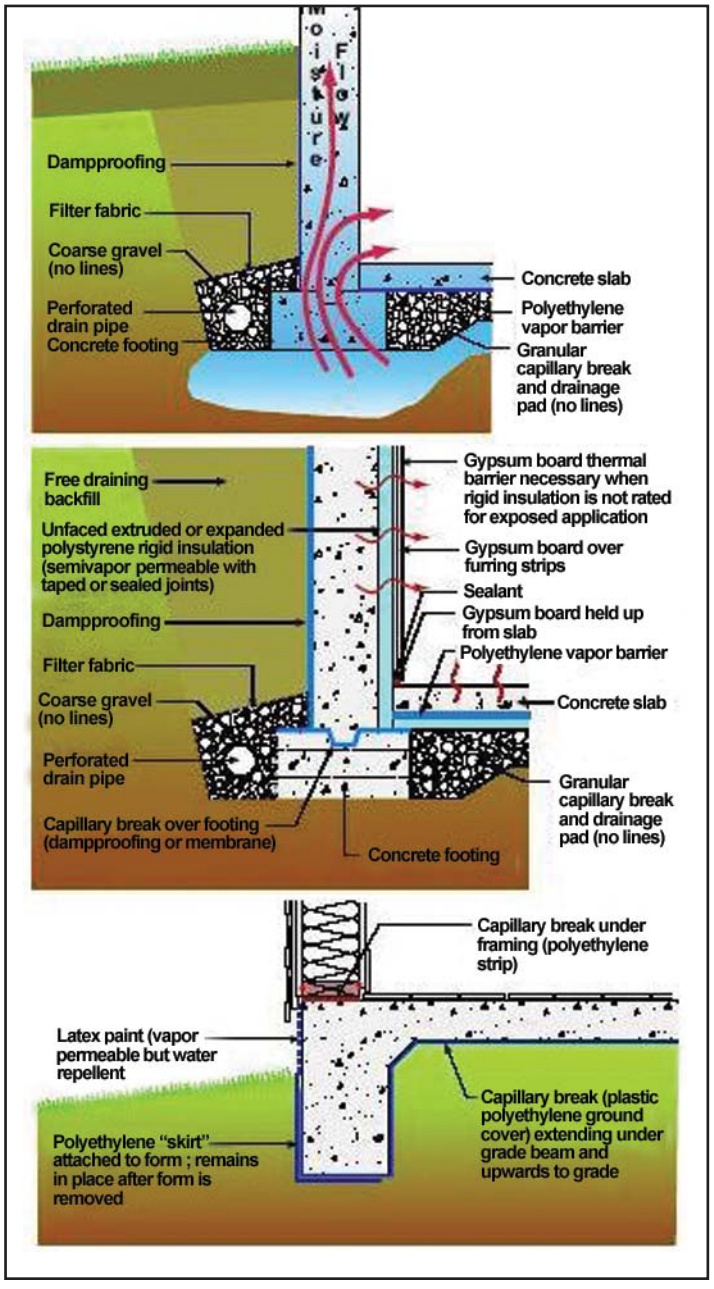

Figure 6.3. Foundation [3]

Holes in the foundation walls are common in many old houses. These holes may be caused by missing bricks or blocks. Holes and cracks in a foundation wall are undesirable because they make a convenient entry for rats and other rodents and also indicate the possibility of further structural deterioration. Basement problems are a major complaint of homeowners [4–9].

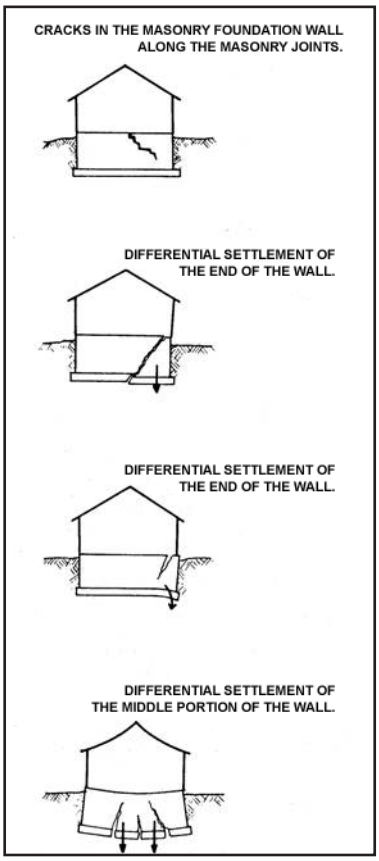

Figure 6.4. Foundation Cracks [4]

Concrete is naturally porous (12%–18% air). When it cures, surplus water creates a network of interconnected capillaries. These pores let in liquid water, water vapor, and radon gas. Like a sponge, concrete draws water from several feet away. As concrete ages, the pores get bigger as a result of freezing, thawing, and erosion.

Concrete paints, waterproofing sealers, or cement coatings are a temporary fix. They crack or peel and cannot stop gases such as water vapor and radon.

Damp basement air spreads mold and radon through the house. Efflorescence (white powder stains) and musty odors are telltale signs of moisture problems.

Basement remodeling traps invisible water vapor, causing mold and mildew. Most basements start leaking within 10 to 15 years. The basement walls and floors should be sealed and preserved before they deteriorate. The basement floor should be concrete placed on at least 6 inches of gravel. The gravel distributes groundwater movement under the concrete floor, reducing the possibility of the water penetrating the floor. A waterproof membrane, such as plastic sheeting, should be laid before the concrete is placed for additional protection against flooding and the infiltration of radon and other gases.

The basement floor should be gradually, but uniformly, sloped from all directions toward a drain or a series of drains. These drains permit the basement or cellar to drain if it becomes flooded.

Water or moisture marks on the floor and walls are signs of ineffective waterproofing or moisture proofing. Cellar doors, hatchways, and basement windows should be weather-tight and rodent-proof. A hatchway can be inspected by standing at the lower portion with the doors closed; if daylight can be seen, the door needs to be sealed or repaired.

Vapor Barriers

Crawl Space Vapor Barriers

Throughout the United States, even in desert areas, there is moisture in the ground from groundwater being absorbed. Even in an apparently dry crawl space, a large amount of water is entering. The moisture is drying out as fast as it is entering, which causes high moisture levels in the crawl space and elsewhere in the house. A solid vapor barrier is recommended in all crawl spaces and should be required if moisture problems exist [10]. This vapor barrier, if properly installed, also reduces the infiltration of radon gas. Of course, if the moisture is coming from above ground, a vapor barrier will collect and hold the moisture. Therefore, any source of moisture must be found and eliminated. The source may be as obvious as sweating pipes, or may be more difficult to spot, such as condensation on surfaces. The solution can be as simple as applying insulation to exposed sections of the piping or complex enough to require power exhaust fans and the addition of insulation and vapor barriers.

The more common causes of moisture problems in a new home are moisture trapped within the structure during construction and a continuing source of excess moisture from the basement, crawl space, or slab. To resolve this potential problem, 6-mil plastic sheets should be laid as vapor barriers over the entire crawl space floor. The sheets should overlap each other by at least 6 inches and should be taped in place. The plastic should extend up the perimeter walls by about 6 inches. The plastic sheets should be attached to the interior walls of the crawl space with mastic or batten strips. All of the perimeter walls should be insulated, and insulation should be between the joists at the top of the walls. Vents, which may need to be opened in the late spring and closed in the fall, should not be blocked. If not properly managed, moisture originating in the crawl space can cause problems with wood flooring and create many biologic threats to health and property. A properly placed vapor barrier can prevent or reduce problem moisture from entering the home.

Vapor Barriers for Concrete Slab Homes

Strip flooring and related products should be protected from moisture migration by a slab. Proper on-grade or above-grade construction requires that a vapor barrier be placed beneath the slab. Moisture tests should be done to determine the suitability of the slab before installing wood products. A vapor barrier equivalent to 4- or 6-mil polyethylene should be installed on top of the slab to further protect the wood products and the residents of the home.

Wall and Ceiling Vapor Barriers

Wall and ceiling vapor barriers should go on the heated side of the insulation and are necessary in cold climates. Water vapor flows from areas of high pressure (indoors in winter) through the wall to an area of low pressure (outdoors in winter). People and their pets produce amazing quantities of water vapor by breathing. Additional moisture in considerable quantities is created in the home from everyday activities such as washing clothes, cooking, and personal hygiene. The purpose of the vapor barrier is to prevent this moisture from entering the wall and freezing, then draining, causing damage. In addition, wet insulation has very little insulating value. Insulation with the vapor barrier misplaced will allow the vapor to condense in the insulation and then freeze. In cold climates, this ice can actually build up all winter and run out on the floor in the spring. Such moisture buildup blisters paint, rots sheathing, and destroys the insulating value of insulation.

House Framing

Many types of house-framing systems are found in various sections of the country; however, most framing systems include the elements described in this section.

Foundation Sills

The purpose of the sill is to provide support or a bearing surface for the outside walls of the building. The sill is the first part of the frame to be placed and rests directly on the foundation wall. It is often bolted to the foundation wall by sill anchors. In many homes, metal straps are cemented into the foundation wall that are bent around and secured to the sill. It is good practice to protect the sill against termites by extending the foundation wall to at least 18 inches above the ground and using a noncorroding metal shield continuously around the outside top of the foundation wall.

Flooring Systems

The flooring system is composed of a combination of girders, joists, subflooring, and finished flooring that may be made up of concrete, steel, or wood. Joists are laid perpendicular to the girders, at about 16 inches on center, and the subflooring is attached to them. If the subfloor is wood, it may be nailed, glued, or screwed at either right angles or diagonally to the joists. Many homes are built with wood I-joists or trusses rather on than solid wood joists.

In certain framing systems, a girder supports the joists and is usually a larger section than the joists it supports. Girders are found in framing systems where there are no interior bearing walls or where the span between bearing walls is too great for the joists. The most common application of a girder is to support the first floor. Often a board known as a ledger is applied to the side of a wood girder or beam to form a ledge for the joists to rest upon. The girder, in turn, is supported by wood posts or steel "lally columns" that extend from the cellar or basement floor to the girder.

Studs

For years, wall studs were composed of wood and were 2×4 inches; but, with the demand for greater energy efficiency in homes, that standard no longer holds true. Frame studs up to 6 inches wide are used to increase the area available for placing insulation material. The increased size in the studs allow for larger spaces between joists.

There are now alternatives to conventional wood studs, specifically, insulated concrete forms, structural insulated panels, light-gauge steel, and combined steel and wood [11–13]. The advantages of light-gauge steel include the following:

- weighs 60% less than equivalent wood units and has greater strength and durability;
- is impervious to termites and other damage-causing pests;
- stays true and does not warp;
- is noncombustible; and
- is recyclable.

The disadvantages of steel include these:

- steel is an excellent thermal conductor and requires additional external insulation;
- as a new product, it is unfamiliar to craftsmen, engineers, and code officials; and
- a different type of construction tools are required.

The combined steel and wood framing system includes light-gauge steel studs with 6-inch wooden stud pieces attached to the top and bottom to allow easy attachment to traditional wood frame materials.

There are two types of walls or partitions: bearing and nonbearing. A bearing wall is constructed at right angles to support the joists. A nonbearing wall, or partition, acts as a screen or enclosure; hence, the headers in it are often parallel to the joists of the floor above.

In general, studs, like joists, are spaced 16 inches on center. In light construction, such as garages and summer cottages, wider spacing on studs is common.

Openings for windows or doors must be framed in studs. This framing consists of horizontal members (headers) and vertical members (trimmers or jack studs).

Because the vertical spaces between studs can act as flues to transmit flames in the event of a fire, fire stops are important in preventing or retarding fire from spreading through a building by way of air passages in walls, floors, and partitions. Fire stops are wood obstructions placed between studs or floor joists to block fire from spreading in these natural flue spaces.

Interior Walls

Many types of materials are used for covering interior walls and ceilings, but the principal type is drywall. The generic term "drywall" is typically used when talking about gypsum board. It is also called wallboard or referred to by the brand name Sheetrock. Gypsum board is a sheet material composed of a gypsum filler faced with paper. In drywall construction, gypsum boards are fastened to the studs either vertically or horizontally and then painted. The edges along the length of the sheet are slightly recessed to receive joint cement and tape.

Drywall finish, composed of gypsum board, is a material that requires little, if any, wait for application. Other drywall finishes include plywood, fiberboard, or wood in various sizes and forms. Plaster was once quite popular for interior walls. Plaster is a mixture (usually of lime, sand, and water) applied in two or three coats to lath to form a hard-wall surface. A plaster finish requires a base on which plaster can be spread. Wood lath at one time was the plaster base most commonly used, but today gypsum-board lath is more popular. Gypsum lath may be perforated to improve the bond and thus lengthen the time the plaster can remain intact when exposed to fire. Building codes in some cities require that gypsum lath be perforated. Expanded-metal lath also may be used as a plaster base. Expanded-metal lath consists of sheet metal slit and expanded to form openings to hold the plaster. Plaster is applied over the base to a minimum thickness of ½ inch. Because wood-framing members may dry after

the house is completed, some shrinkage can be expected, which, in turn, may cause plaster cracks to develop around openings and in corners. Strips of lath embedded in the plaster at these locations prevent cracks. Bathrooms have unique moisture exposure problems and local code approved cement board should be used around bath and shower enclosures.

Stairways

The purpose of stairway dimension standards is to ensure adequate headroom and uniformity in riser and tread size.

Interior stairways (Figure 6.5) should be no less than 44 inches wide. The width of a stairway may be reduced to 36 inches when permitted by local or state code in one- and two-family dwellings. Stairs with closed risers should have maximum risers of 8¼ inches and minimum treads of 9 inches plus 1 inch nosing. Basement stairs are often constructed with open risers. These stairs should have maximum risers of 8¼ inches and minimum treads of 9 inches plus 1-inch nosing. The headroom in all parts of the stair enclosure should be no less than 80 inches. Dimensions of exterior stairways should be the same as those of interior stairways, except that the headroom requirement does not apply.

Staircases should have handrails that are between 1¼ and $2\frac{5}{8}$ inches wide, particularly if the staircases have more than four steps. Handrails should be shaped so they can be readily grasped for safety and placed so they are easily accessible. Handrails should be $4\frac{1}{8}$ inches from the wall and be 34 to 38 inches above the leading edge of the stairway treads. Handrails should not end in any manner or have projections that can snag clothing.

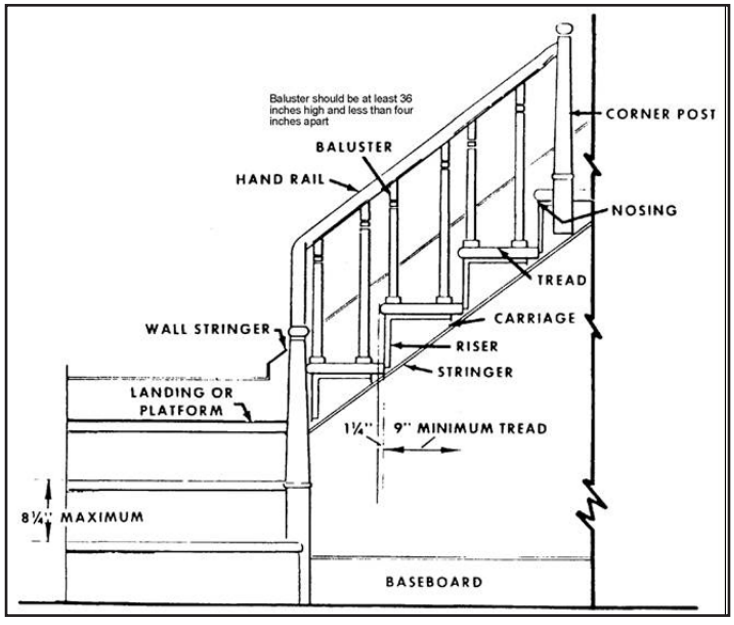

Figure 6.5. Interior Stairway [4]

Windows

The six general classifications of windows (Figure 6.6) are as follows [1]:

- Double-*hung* sash windows that move up or down, balanced by weights hung on chains, ropes, or springs on each side;
- *Casement* sash windows that are hinged at the side and can be hung so they will swing out or in;
- *Awning* windows that usually have two or more glass panes that are hinged at the top and swing out horizontally;
- *Sliding* windows that usually have two or more glass panes that slide past one another on a horizontal track;
- *Fixed* windows that are generally for increased light entry and decorative effect; and
- *Skylight* windows for increased room illumination and decoration that can be built to open.

The principal parts of a window, shown in three-dimensional view in Figure 6.7 and face-on and side view in Figure 6.8, are the following:

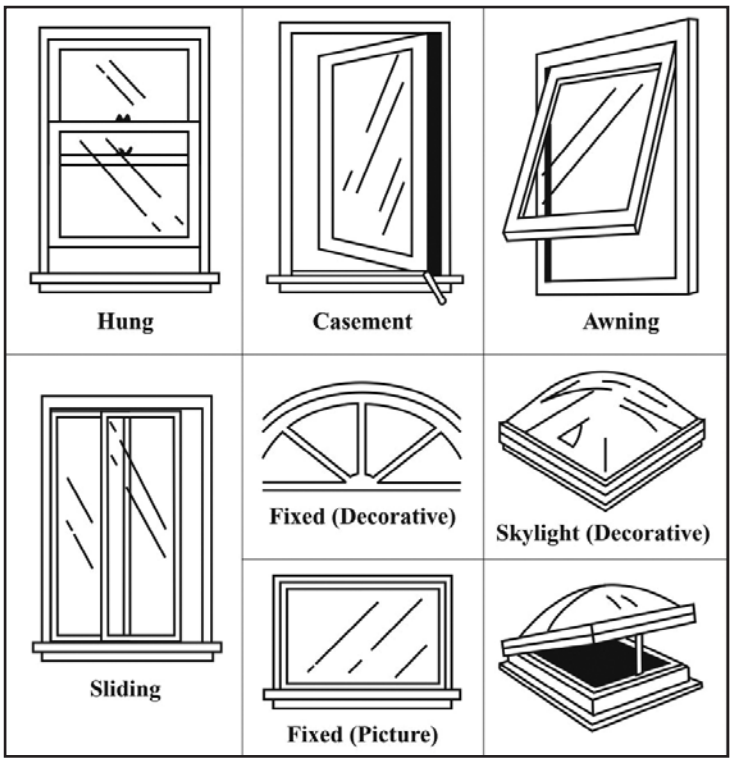

Figure 6.6. Classifications of Windows [1]

Drip cap—A separate piece of wood projecting over the top of the window; a component of the window casing. The drip cap protects against moisture.

Window trough—The cut or groove in which the sash of the window slides or rests.

Window sill—The shelf on the bottom edge of a window, either a projecting part of the window frame or the bottom of the wall recess that the window fits into. The sill contains the trough and protects against moisture.

Recent technological advancements—new materials, coatings, design, and construction features—make it possible to choose windows that allow you to balance winter heating and summer cooling needs without sacrificing versatility or style. To ensure that windows, doors, or skylights selected are appropriate for the region in which they are to be installed, Energy Star Certification labels include a climate region map.

Some window glass is made of tempered glass to resist breakage. Some windows are made of laminated glass, which resists breakage, but if broken produces glass shards too small to cause injury [14]. The glazing, or glass, can be a solid glass sheet (single glazed) or have two layers of glass (double glazed) separated by a spacer. Air trapped between the glass layers provides some insulation value. Triple-glazed windows have three pieces of glass, or two layers of glass with a low emissivity film suspended between them. Triple-glazed windows have advantages where extremes in weather and temperature are the norm. They also can reduce sound transmission to a greater degree than can single- or double-glazed windows.

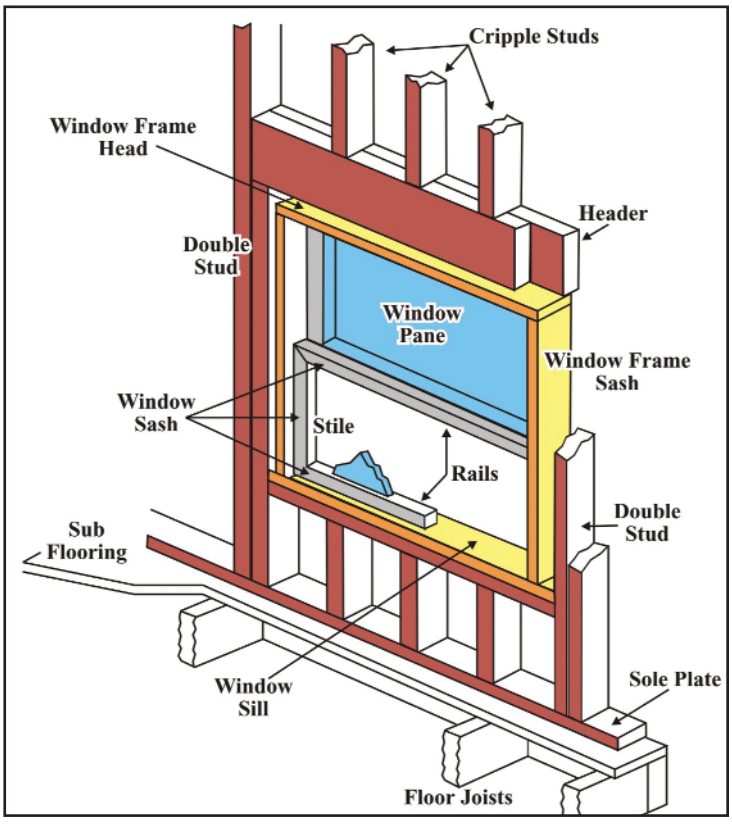

Figure 6.7. Three Dimensional View of a Window [1]

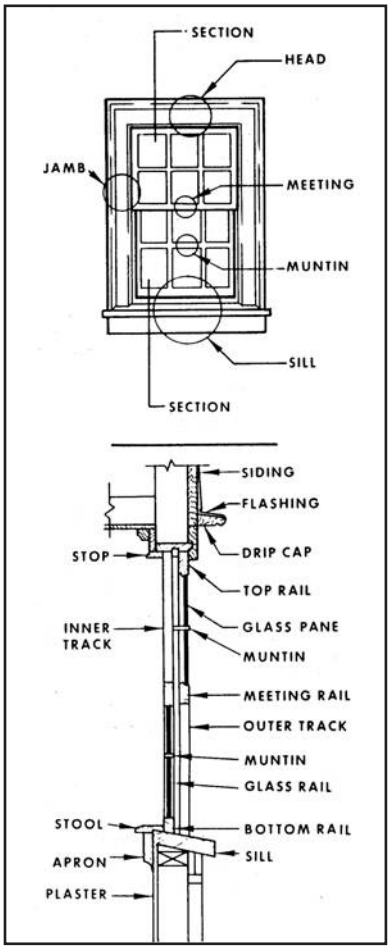

Figure 6.8. Window Details [3]

Doors

There are many styles of doors both for exterior and interior use. Exterior doors must, in addition to offering privacy, protect the interior of the structure from the elements. Various parts of a door are the same as the corresponding parts of a window. A door's function is best determined by the material from which it is made, how it looks, and how it operates. When doors are used for security, they are typically made from heavy materials and have durable, effective locks and hinges. A door that lets in light or allows people to look out onto the yard, such as a sliding glass door or a french door, will have multiple panes (also called lights) or be made almost completely of glass.

Houses have many exterior and interior door options. Exterior doors are typically far sturdier than interior doors and need to be weather tight and ensure security for the home. Exterior doors are also more decorative than most interior doors and may cost a considerable amount. Typical exterior doors include front entry doors, back doors, french doors, dutch doors, sliding glass doors, patio doors, and garage doors.

French doors and sliding doors are examples of the two primary ways doors open. French doors swing on hinges; sliding doors glide along a track. Some doors, such as dutch doors, have tops and bottoms that swing open independently.

Most doors are made of wood or materials made to look like wood. Fiberglass composite and steel doors often have

polymer or vinyl coatings embossed with wood grain; some even have cellulose-based coatings that can be stained like wood doors. Wood doors are made from every kind of wood imaginable, hardwoods being the most durable and elegant. Wood doors insulate better than glass; composite and steel doors provide even more insulation and durability, as well as better security than does wood.

Garage Doors

Garage doors open in almost any configuration needed for the design of the home. Installing most garage doors is complex and dangerous enough that only a building professional should attempt it. Garage doors often include very strong springs that can come loose and severely injure the unsuspecting installer. Garage door springs are under extreme tension because of the heavy loads they must lift, which makes them dangerous to adjust. A garage door may suffer from any of several problems. The most common problem is that the door becomes difficult to lift and lower. This may be something that can be resolved with simple adjustments, or it may be more serious. If the door is connected to an electric opener, the opener mechanism can be disconnected from the door by pulling the release cord or lever. If the door then works manually, the problem is with the electric opener. A door that seems unusually hard to lift may have a problem with spring tension. Wood doors should be properly painted or stained both outside and inside. If only the outside of a garage door is finished, the door may warp and moisture may cause the paint to peel.

Rules issued by the Consumer Product Safety Commission on December 3, 1992, specify entrapment protection requirements for garage doors [15].

The rules require that residential garage door openers contain one of the following:

- An external entrapment protection device, such as an electric eye that sees an object obstructing the door without having actual contact with the object. A door-edge sensor is a similar device. The door-edge sensor acts much like the door-edge sensors on elevator doors.

- A constant contact control button, which is a wall-mounted button requiring a person to hold in the control button continuously for the door to close completely. If the button is released before the door closes, the door reverses and opens to the highest position.

- A sticker on all newly manufactured garage door openers warning consumers of the potential entrapment hazard. The sticker is to be placed near the wall-mounted control button.

The variety of exterior door systems has increased significantly over the past 5 to 10 years. Many combine several different materials to make a realistic, if not actual wood, door that provides both beauty and enhanced security.

Exterior House Doors

Exterior door frames are ordinarily of softwood plank, with the side rabbitted to receive the door in the same way as casement windows. At the foot is a sill, made of hardwood or other material, such as aluminum, to withstand the wear of traffic and sloped down and out to shed water. Doors often come equipped with door sweeps to conserve energy.

The four primary categories of modern exterior doors are steel, fiberglass, composites, and wood.

Steel—The most common exterior door sold today is steel. Humidity will not cause a steel door to warp or twist. Steel doors often have synthetic wood-grain embossed finishes that accept stain. Just about every steel exterior door is filled with some type of foam. This foam allows the doors to achieve R-values almost five times that of an ordinary wood door. Metal is often used as a veneer frame. In general, the horizontal members are called rails and the vertical members are called stiles. Every door has a top and bottom rail, and some may have intermediate rails. There are always at least two stiles, one on each side of the door.

Fiberglass—The second most frequently selected exterior door is fiberglass. Fiberglass doors are similar to steel doors, but tend to be much more resistant to denting. (Steel doors can be dented quite easily.) Fiberglass doors also are stainable and have rich, realistic wood graining. Fiberglass doors are insulated with foam and have high R-values.

Composite materials—The third most common exterior door is made of composite materials. These doors often are of two materials blended together. Their composite fiber-reinforced core can be twice as strong as wood. This composite core will not rot, warp, or twist when subjected to high levels of humidity.

Wood—The last major category of doors is wood. Solid wood doors range from inexpensive to true works of art. Their downside is that they can warp and bow if not sealed properly from humidity and will then fit poorly in their frames.

Other types of wooden doors are described below.

- *Batten doors* are often found on older homes. They are made of boards nailed together in various ways. The simplest is two layers nailed to each other at right angles, usually with each layer at 45° to the vertical. Another type of batten door consists of vertical boards nailed at right angles to several (two to four) cross strips called ledgers, with diagonal bracing members nailed between the ledgers. If vertical members corresponding to ledgers are added at the sides, the verticals are called frames. Batten doors are often found in cellars and other places where appearance is not a factor and economy is desired.

- *Solid flush doors* are perfectly flat, usually on both sides, although occasionally they are made flush on one side and are paneled on the other. Flush doors sometimes are solid planking, but they are commonly veneered and possess a core of small pieces of white pine or other wood. These pieces are glued together with staggered end joints. Along the sides, top, and bottom are glued ¾ inch edge strips of the same wood, used to create a smooth surface that can be cut or planed. The front and back faces are then covered with a $\frac{1}{8}$-inch to ¼-inch layer of veneer. Solid flush doors may be used on both the interior and exterior.

- *Hollow-core doors*, like solid flush doors, are perfectly flat; but, unlike solid doors, the core consists mainly of a grid of crossed wooden slats or some other type of grid construction. Faces are three-ply plywood instead of one or two plies of veneer, and the surface veneer may be any species of wood, usually hardwood. The edges of the core are solid wood and are made wide enough at the appropriate places to accommodate locks and butts. Doors of this kind are considerably lighter than solid flush doors. Hollow-core doors are usually used as interior doors.

Many doors are paneled, with most panels consisting of solid wood or plywood, either raised or flat, although exterior doors frequently have one or more panels of glass. One or more panels may be used, although some have as many as nine panels. Paneled doors may be used both on the interior or exterior.

The frame of a doorway is the portion to which the door is hinged. It consists of two side jambs and a head jamb, with an integral or attached stop against which the door closes.

Roof Framing

Rafters

One of a series of structural roof members spanning from an exterior beam or a ridge board. Rafters serve the same purpose for the roof as joists do for floors, that is, providing support for sheathing and roofing material. They are typically placed on 16-inch centers.

Collar Beam

Collar beams are ties between rafters on opposite sides of the roof. If the attic is to be used for rooms, the collar beam may double as the ceiling joist.

Purlin

A purlin is the horizontal member that forms the support for the rafters at the intersection of the two slopes of a gambrel roof.

Ridge Board

A ridge board is a horizontal member that forms a lateral tie to make rafters secure.

Hip

A hip is like a ridge, except that it slopes. It is the intersection of two adjacent, rather than two opposite, roof planes.

Roof Sheathing

The manner in which roof sheathing is applied depends upon the type of roofing material. Roof boards may vary from tongue-and-groove lumber to plywood panels.

Dormer

The term “dormer window” is applied to all windows in the roof of a building, whatever their size or shape.

Roofs

Asphalt Shingle

The principal damage to asphalt shingle roofs is caused by strong winds on shingles nailed close to the ridge line of the roof. Usually the shingles affected by winds are those in the four or five courses nearest the ridge and in the area extending about 5 feet down from the edge or rake of the roof.

EPDM

Ethylene propylene diene monomer (EPDM) is a single-ply roofing system. EPDM allows extreme structural movement without splitting or cracking and retains its pliability in a wide range of temperatures.

Asphalt Built-up Roofs

Asphalt roofs may be unsurfaced (a coating of bitumen being exposed directly to the weather) or surfaced (with slag or gravel embedded in the bituminous coating). Using surfacing material is desirable as a protection against wind damage and the elements. This type of roof should have enough pitch to drain water readily.

Coal Tar Pitch Built-up Roofs

This type of roof must be surfaced with slag or gravel. A coal tar pitch built-up roof should always be used on a deck pitched less than ½ inch per foot; that is, where water may collect and stand. This type of roof should be inspected on completion, 6 months later, and then at least once a year, preferably in the fall. When the top coating of bitumen shows damage or has become badly weathered, it should be renewed.

Slate Roofs

The most common problem with slate roofs is the replacement of broken slates. Otherwise, slate roofs normally render long service with little or no repair.

Tile Roofs

Replacement of broken shingle tiles is the main maintenance problem with tile roofs. This is one of the most expensive roofing materials. It requires very little maintenance and gives long service.

Copper Roofs

Usually made of 16-ounce copper sheeting and applied to permanent structures, copper roofs require practically no maintenance or repair when properly installed. Proper installation allows for expansion and contraction with changes in temperature.

Galvanized Iron Roofs

The principal maintenance for galvanized iron roofs involves removing rust and keeping the roof well painted. Leaks can be corrected by renailing, caulking, or replacing all or part of the sheet or sheets in disrepair.

Wood Shingle Roofs

The most important factors of wood shingle roofs are their high pitch and exposure, the character of wood, the kind of nails used and the preservative treatment given the shingles. At one time these roofs were treated with creosote and coal tar preservatives. Because they are made from a flammable material, insurance companies frequently have higher rates for wood shingle roofs.

Roof Flashing

Valleys in roofs (such as gambrel roofs, which have two pitches designed to provide more space on upper floors and are steeper on their lower slope and flatter toward the ridge) that are formed by the junction of two downward slopes may be open or closed. In a closed valley, the slates, tiles, or shingles of one side meet those of the other, and the flashing below them may be comparatively narrow. In an open valley, the flashing, which may be made of zinc, copper, or aluminum, is laid in a continuous strip, extending 12 to 18 inches on each side of the valley, while the tiles or slates do not come within 4 to 6 inches of it. The ridges built up on a sloping roof where it runs down against a vertical projection, like a chimney or a skylight, should be weatherproofed with flashing. Failure of roof flashing is usually due to exposed nails that have come loose. The loose nails allow the flashing to lift, resulting in leakage. Flashings made of lead or coated with lead should not be used.

The use of a thin, self-sticking rubber ice and water shield under flashings and on the edge of roofs is now common practice. The shield helps reduce leakage and ice backup in cold climates, preventing serious damage to this part of the home.

Gutters and Leaders

Gutters and leaders should be of noncombustible materials and should not be made of lead, lead-coated copper, or any other formulation containing lead. They should be securely fastened to the structure and spill into a storm sewer, not a sanitary sewer, if the neighborhood has one. When there is no storm sewer, a concrete or stone block placed on the ground beneath the leader prevents water from eroding the lawn. This stone block is called a splash block. Gutters should be checked every spring and fall and cleaned when necessary. Gutters must be placed or installed to ensure that water drainage is taken away from the foundation of the house. Soil around the home should be graded in a manner that also drains the water away from the foundation of the home.

Exterior Walls and Trim

Exterior walls are enclosure walls whose purpose is not only to make the building weather tight, but to also allow the building to dry out. In most one- to three-story buildings they also serve as bearing walls. These walls may be made of many different materials (Figure 6.9).

Brick is often used to cover framed exterior walls. In this situation, the brick is only one course thick and is called a brick veneer. It supports nothing but itself and is kept

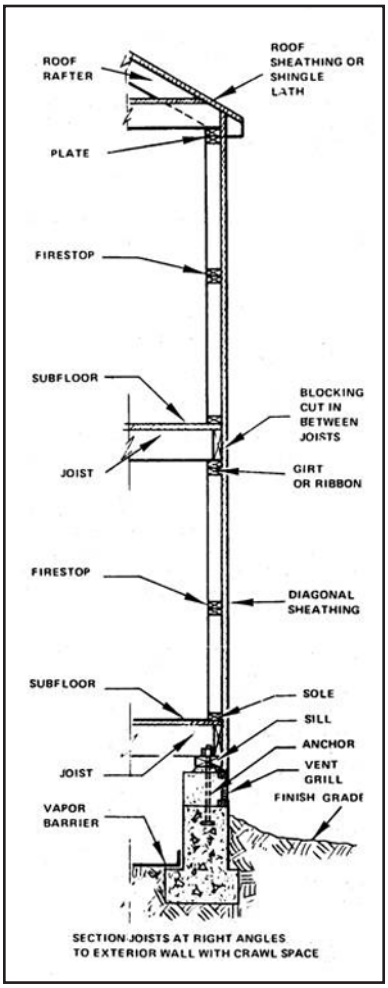

Figure 6.9. Wall Framing [4]

from toppling by ties connected to the frame wall.

In frame construction, the base material of the exterior walls is called sheathing. The sheathing material may be square-edge, shiplap, tongue-and-groove boards, or plywood or oriented strand board (OSB). Sheathing, in addition to serving as a base for the finished siding material, stiffens the frame to resist sway caused by wind. It is for this reason that sheathing is applied diagonally on frame buildings. Its role is to brace the walls effectively to keep them from racking.

Many types of sidings, shingles, and other exterior coverings are applied over the sheathing. Vinyl siding; wood siding; brick, cedar, and other wood shingles or shakes; asphalt; concrete; clapboard; common siding (called bevel siding); composition siding; cement shingles; fiber cement (e.g., Hardiplank); and aluminum siding are commonly used for exterior coverings. In older homes, asbestos-cement siding shingles can still be found as an exterior application or underneath various types of aluminum or vinyl siding.

Clapboard and common siding differ only in the length of the pieces. Composition siding is made of felt, grit, and asphalt, which are often shaped to look like brick. Asbestos and cement shingles, which were used until the early 1970s, are rigid and produce a siding that is fire-resistant, but also a health hazard. Cedar wood shingles and aluminum are manufactured with a backer board that gives insulation and fire-resistant qualities. Vinyl siding is manufactured from polyvinyl chloride (PVC), a building material that has replaced metal as the prime material for many industrial, commercial, and consumer products. PVC has many years of performance as a construction material, providing impact-resistance, rigidity, and strength. The use of vinyl siding is not without controversy, because PVC is known to cause cancer in humans. Accidental fires in vinyl-sided buildings are more dangerous because vinyl produces toxic vapors when heated.

Putting It All Together

The next section shows a home being built by Habitat for Humanity.

This small, one-family home represents all of the processes that would also be used for a far more expensive and elaborate dwelling. The homebuilding demonstrated by the following pictures was by an industrial arts class to educate and train a new generation of construction specialists and homebuilders.

A.
The foundation trench for a new home has horizontal metal rods, also called reinforcement rods or rebar, to increase the strength of the concrete. After the concrete hardens, a perforated pipe 4 to 6 inches in diameter is placed beside it to collect water and allow it to drain away from the foundation. This pipe is the footing drain, and the poured concrete beside it is the footer. The footing drain is important in removing water from the base of the home. It also serves the secondary purpose of moisture control in the home and provides a venting route for radon gas. The holes dug near the legs of the workers will be filled with concrete and form the footer that will hold up the porch of the home.

To assist in preventing capillary action from wicking water from the foundation to the wooden structure, a polyethylene sheet is placed over the footer before pouring the concrete foundation, or building a cinderblock foundation.

B.
The concrete on top of the footer is leveled to establish a surface for the foundation of the home. Once the footer has hardened, the perforated drainage pipe will be laid on the outside of the poured foundation wall. The reinforcing rods were positioned in the trench before pouring the concrete.

C.
Concrete will be poured into this form on top of the footer to create the foundation of the home. Again, reinforcing rods are added to ensure that the concrete has both lateral strength, as well as the strength to support the home. Once the concrete has hardened and becomes seasoned, the forms will be removed to reveal the finished poured concrete foundation over the perforated drainage pipe. Not shown is a newer technique of using insulating polystyrene forms and ties in a building foundation.

D.
Foundations are not always poured concrete, but are often cinderblock or similar materials that are cemented in place to form the load-bearing wall. The arrow shows the concrete chute delivering concrete into the form. Long poles are pushed into the freshly poured concrete to remove air pockets that would weaken the foundation.

Care must be taken to ensure that the forms are appropriately supported before pouring the concrete. Often tar, plastic, or other waterproof materials are placed on the outside of the foundation to the ground level to further divert moisture from the house to the footing drains.

E.
Gravel fill is placed outside the finished poured concrete foundation. This ensures that moisture does not stand around the foundation for any time. The moisture is routed to the footing drain for fast dispersal.

F.
A termite shield is established on top of the concrete wall (foundation) just below the sill of the home. The sill is typically made of pressure- and insecticide-treated wood to ensure stability and long life.

A cinderblock foundation will be used to support the storage shed attached to the house. Note the potential for inadvertent sabotage of the termite shield if a shield is not installed on the top of the cinder block foundation.

G.
OSB subfloor, the joist supporting the floor, and the metal bridging that is used to keep the joist from twisting can be seen from the crawl space under the home.

If the material used for the flooring or external sheathing of the home is made of plywood or a composition that is not waterproof, the material must be protected from rain to prevent deterioration and germination of mold spores. Some glues or resins release toxic vapors for years if deterioration is allowed to begin.

H.
The flooring material of the first floor of the home is OSB applied to the subfloor with both glue and wood screws. Where possible, the screws should extend into the subfloor and the joist below the subfloor to prevent squeaking.

I.
The interior wall framing is composed of studs traditionally referred to as 2×4s. The horizontal member at the top of the studs is called a girt or a ribbon. In this case the builders have used two 2×4s, placing one on top of the other. Because the outside walls have used studs that are 2×6-inch boards, the girts or ribbons on top of these are also double 2×6-inch boards.

J.
The exterior wall framing is composed of studs that are 2x6-inch boards. The horizontal member extending from one exterior wall to the other is called a girder and is a prime support for the second floor of the home. The larger studs in the exterior wall are used both for greater strength and to provide greater energy efficiency for the home.

The lintels above the windows and doors distribute the weight of the second floor and roof across the studs that are located on each side of the openings in the frame.

K.
The joists above the first floor are connected to the central girder of the home by steel brackets. These brackets provide a far more effective alternative than does toenailing nails to hold the joists in place or to notching the girder to hold them.

L.
The subroof or roof sheathing is applied from the bottom up with temporary traction boards nailed to the subroof to allow safe installation of the material.

The subroof is placed on the rafters up to the ridge board of the roof. A waterproof material will be added to the subroof before installing the final roofing material.

M.
An interior wall is installed to create second-floor rooms.

The subroof has been installed.

The exterior wood of the home has been covered with plastic sheathing or a housewrap to protect it from moisture.

N.
Flashing material, such as sheet metal, is installed at critical locations to make sure that water does not enter the home where the joints and angles of a roof meet:

- where the dormer roof meets the roof and the walls of the dormer meet the roof,
- where windows penetrate the walls,
- where the vent stack penetrates the roof,
- where the porch roof meets the front wall,
- skylights, and
- eaves of the house.

O.
A safety scaffold is standing at the rear of the home, and the final roofing material has been applied, in addition to the exterior vinyl siding.

P.
The front porch of the home is constructed of pressure-treated, insect-resistant lumber. The use of such lumber should be carefully evaluated with respect to what chemicals have been used and the potential for human exposure to the treated wood. Composite wood products and plastic decking materials, collectively called Trex, are available as an alternative to pressure-treated wood. A proper hand railing and balusters will be installed.

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