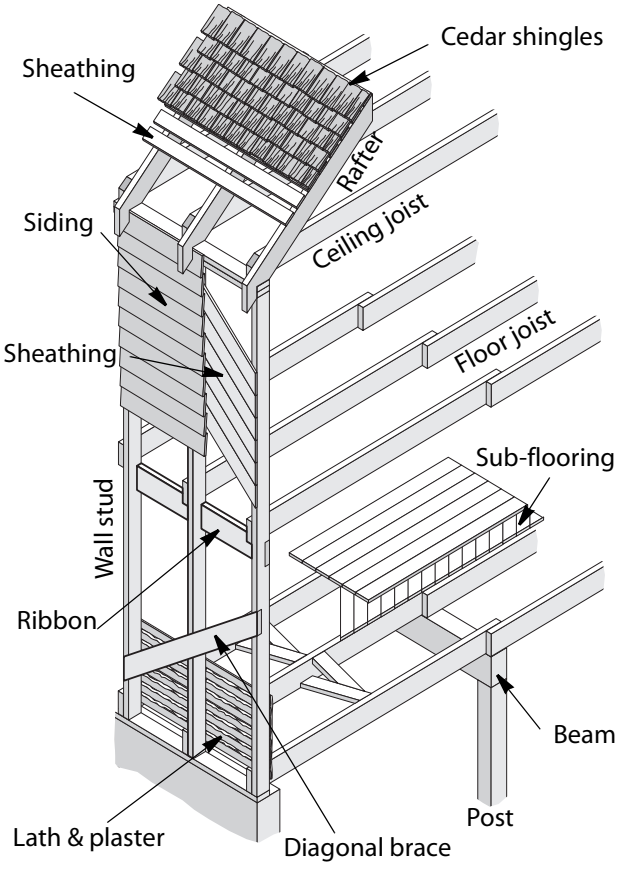
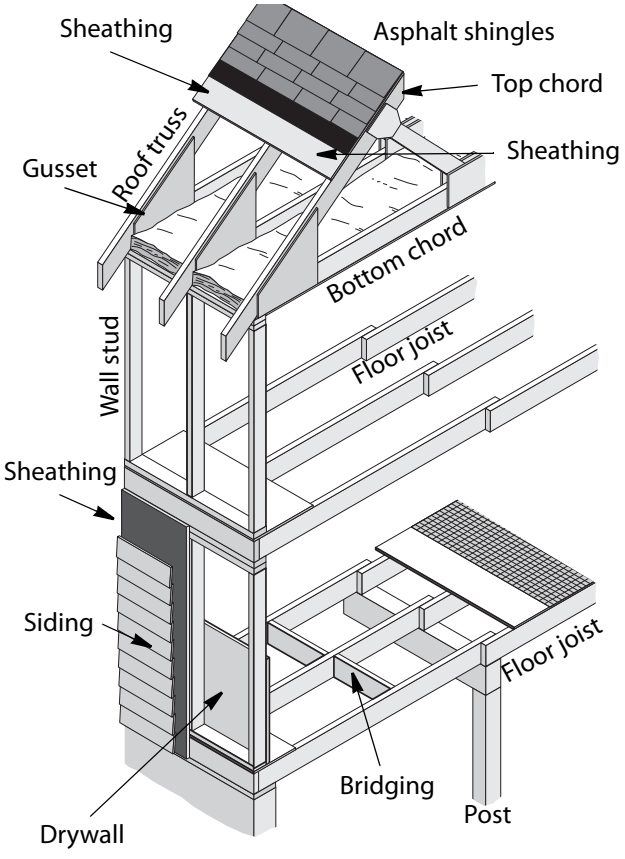
Balloon Framing



Platform Framing



Balloon framing is characteristic of some older homes. The wall cavities of balloon-framed houses are often open to both the basement and the attic. Modern homes on the other hand, feature pre-built roof trusses, platform framing, and 4′ x 8′- sheets of plywood or OSB sheathing material for walls, floors and ceilings.

SATURN
RESOURCE MANAGEMENT

Building Construction

Buildings have construction flaws that waste energy, reduce comfort, and encourage building deterioration. Knowledge about construction characteristics helps you locate and correct these flaws.

Building materials have different thermal conductivities. Metals such as aluminum and steel conduct heat rapidly, while insulating materials such as mineral fiber and plastic foam conduct heat slowly. The thermal conductance of wood, masonry, and plastic are between these extremes.

The simplest buildings are just large six-sided rectangular boxes. The building shell includes its foundation, bottom floor, exterior walls, and roof assembly. These components generally have at least two layers with a cavity between. For example, a wall has interior sheeting and exterior siding; the roof assembly has a ceiling inside and a roof outside.

The building shell's seams at edges, corners, and around openings are the obvious thermal weak points, containing heat-conductive structural members and leaky joints between building materials.

Penetrations through insulation and air barriers occur where mechanical and electrical components pass through the building shell. These are often major flaws in the building shell.

Protrusions and indentations to the building's shell create seams, thermal bridges, and areas where the insulation and air barrier aren't continuous. Protrusions include bay windows, dormers, and porches. Indentations include recessed entrances, porches, and windows. These building-shell irregularities promote air leakage between indoors and outdoors and convection within building cavities.

Structural Design

Building structures are classified as planer or skeletal design, depending on whether they are supported by columns and beams or by panels. Many buildings combine these two structural styles.

Planer construction is usually simpler (such as masonry or framed walls) with familiar interior and exterior surfaces. Wood-frame structures have many joints between their different components, making airtightness an important design and construction issue. Insulation is installed between the framing and sometimes attached over the framing to reduce conduction through these structural components. Masonry structures, when they are insulated, have surface-applied insulation. See "Home Types and Average Energy Costs" on page 13.

Skeletal construction often contains deeper floor and ceiling cavities and more vertical shafts than planer construction. The steel columns and beams of a skeletal steel framework are hidden behind non-structural walls and suspended ceilings. Less-conductive building components called thermal breaks are used to separate metal, concrete, and glass from each other. A thermal break prevents direct linkage between indoors and outdoors through these very conductive materials.

Foundations support the building with masonry walls, piers, or slabs. They transfer this weight to the ground and also tie the building to the ground for seismic and wind resistance. Masonry materials are preferred for foundations because they are heavy and they resist rot and corrosion.

Foundations should be surrounded by dry ground. However, in real life, they frequently encounter ground moisture or runoff from surrounding roofs or adjacent land. Consider foundation moisture problems when planning weatherization projects.

Single-family Home Construction

Many wood-frame homes, built before 1940, used *balloon-frame construction*, which features wall studs that may be two stories high. These tall studs usually have no top or bottom plates. Floor joists and ceiling joists are attached to the studs and supported by ribbons. The stud cavities are often open to both the basement and attic.

Modern wood-frame homes are generally of *platform-frame construction*. Each floor, framed with structural lumber and sheathed with plywood or particle board, serves as a platform for framing the exterior walls. The top plate of the first floor's exterior wall becomes the platform for framing the second floor and walls.

Some homes may have elements of both styles of framing. For example, newer balloon-framed homes may have a bottom plate that sits on the first floor. A platform-framed split-level home may have a balloon-framed interior wall in the center of the home.

More modern homes use plywood or composite board to sheath exterior walls, roof, and floor. Drywall usually covers the interior surfaces. Siding includes a wide variety of materials such as: wood, brick, composite wood material, vinyl, steel, and aluminum. Some modern homes use steel studs, which require insulated sheathing to prevent severe thermal bridging.

Older homes used $^{3}/_{4}$-to-1 $^{1}/_{4}$-inch-thick lumber as roof and wall sheathing and sub-flooring. Lath and plaster usually covered interior wall and ceiling framing. Slate, cedar, and tile were widely used as roof shingles, although most have been replaced with asphalt or fiberglass shingles. Siding materials included stucco, brick, asbestos shingle, and wood. You can expect to find multiple layers of sheathing on some interior and exterior surfaces of older homes, because workers installed one layer of roofing, siding, or interior sheathing over another through the decades.

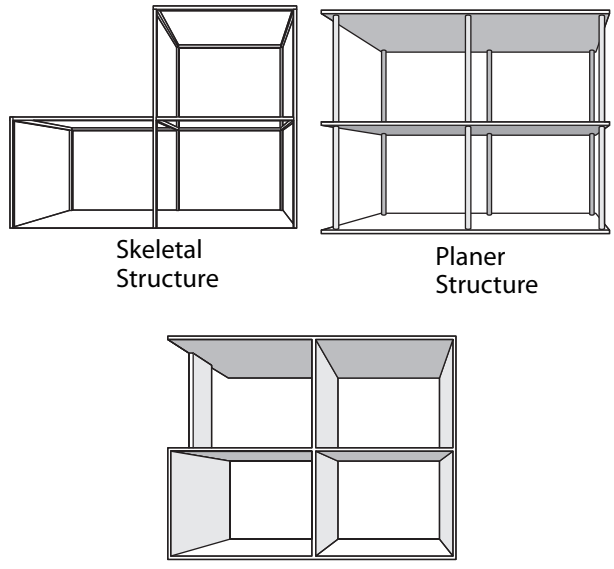
The exterior walls of some homes are made completely of masonry materials: block, brick, concrete, or stone. Masonry materials have low R-values, but the effect of their mass may slow heat transmission significantly in warmer climates.

See "Mass Factors for 6-inch Concrete Walls Insulated Interior or Exterior for Six Locations" on page 280.

Single-family: points of weakness — A home's energy weaknesses are usually concentrated around irregularities in its building shell. A building's protrusions and indentations, with their increased seams and surface area, are particular problems at the following locations:

- Porches.
- Roof overhangs.
- Shafts containing chimneys and pipes.
- Protruding or indented windows and doorways.
- Crawl spaces and basements connecting the home to outdoors.

Structural Types



A building's structure may be skeletal, planer, or a combination of both.

Outdoor and indoor air can mingle in cavities of a building's shell — especially where the shell is penetrated or discontinuous. This reduces the effectiveness of insulation. Here are some areas to watch for:

- Wall cavities partially or completely devoid of insulation.
- Suspended ceilings between floors.
- Attics and roof cavities.
- Concentrations of plumbing pipes near bathrooms and kitchens.
- Concentrations of wires near the service panel box.
- Building cavities used as ducts.
- Interconnecting spaces between floor, wall, and ceiling cavities.

See "Single-family Structural Leakage Sites" on page 93.

Multifamily Building Construction

Multifamily buildings employ a wide variety of construction methods. Smaller multifamily buildings are similar to homes using masonry and wood frame construction. Multistory residential buildings usually have nearly flat, trussed roofs with built-up asphalt roofing, metal roofing, or synthetic rubber roofing over wood, concrete, or steel roof decks.

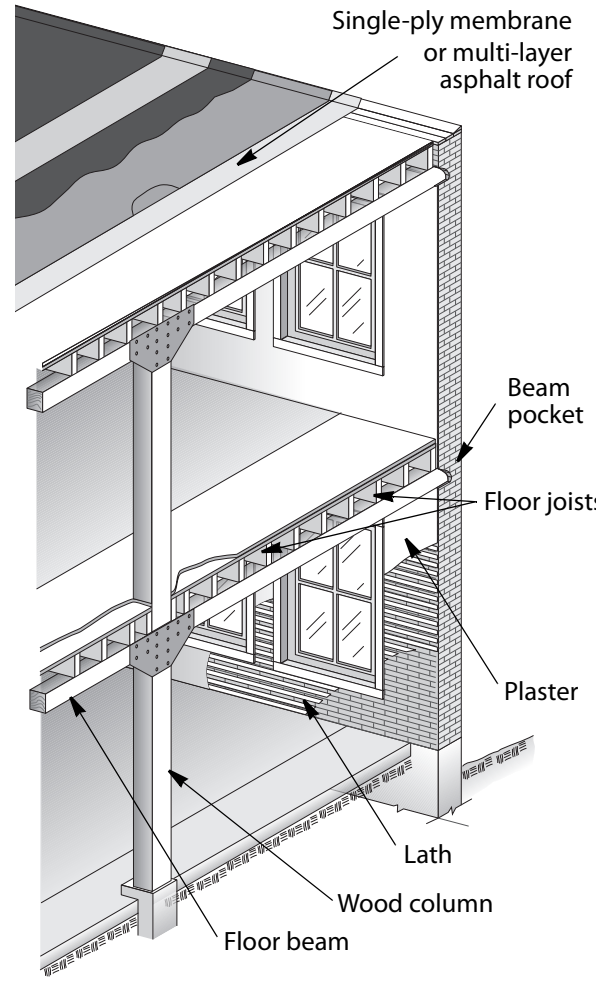
Concrete and steel are the main structural materials in many larger multifamily buildings. Steel skeletons are common for high rises. Floors are often reinforced concrete poured over corrugated metal decking. The walls may be non-structural curtains of lightweight steel and aluminum frames, glass, and metal sheeting.

Some multifamily structures are built with concrete columns and reinforced concrete floors. Some concrete floors have integral concrete beams that form large T-shaped floor sections.

Larger residential buildings, such as high-rises, have less exterior surface area per square foot of floor area than homes, making heat transmission through the shell relatively less important than in smaller buildings. High-rises also have relatively higher internal heat gains from people, lights, appliances, and other heat sources. Internal heat helps warm the building in winter, but adds to the cooling load in summer. In fact, cooling may dominate the high-rise's energy costs — even in spring and fall. Most of this accumulating heat is internal heat, solar heat, and air leakage.

Airtightness and solar reflectance are very important to minimizing multifamily shell-related energy consumption. Weather-tightness and airtightness are important for preventing building deterioration. Protecting the very heat-conductive steel framework from condensation in both the heating and cooling seasons is also vitally important for durability.

Masonry and Heavy Timber Construction

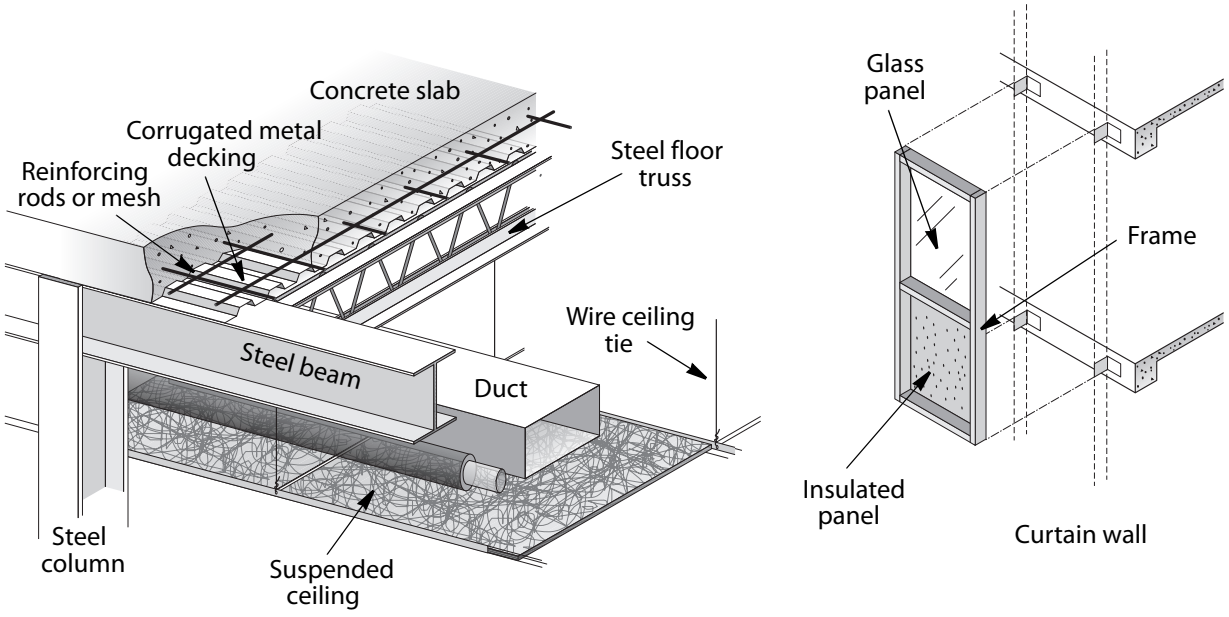


Many older apartment buildings are a combination of brick and heavy-timber construction. Roof framing may involve trusses.

Multifamily: points of weakness — Irregularities on the exteriors of multifamily buildings are potential sources for infiltrating and exfiltrating air. The following protrusions, indentations, and penetrations are weaknesses:

- Thermal bridging from steel and aluminum components.
- Protruding or recessed balconies, eaves, windows, and canopies.
- Roof protrusions and penetrations, such as rooftop elevator shacks and air handlers.

Concrete and Steel Construction



Concrete and steel construction is common in large high-rise residential buildings. Thermal bridging — rapid heat conduction through heat conductors — speeds heat loss and solar heat gains between metal, concrete, and glass.

- Air intake and exhaust vents for heating, cooling, and ventilation systems.

A multifamily building's horizontal cavities and vertical shafts are conduits for air leakage and mixing of indoor and outdoor air. These include:

- Suspended ceilings.
- Supply ducts in floor and ceiling cavities.
- Building cavities used as return ducts.
- Elevator shafts.
- Ventilation shafts.
- Plumbing shafts.
- Chimneys.
- Stairwells.

See "Multifamily Buildings — Air Leakage" on page 97.

Mobile Home Construction

About 6% of the homes in the U.S. are mobile homes. A mobile home is a factory-built wood-framed building, attached to a steel trailer or chassis. Workers assemble components such as the roof, floor, or walls separately and fasten them together later on the assembly line.

The wood-frame floor assembly fastens to a steel trailer. Water lines, waste lines, ducts, insulation, and the underbelly (the protective covering underneath the floor) all attach to the floor before workers bolt the floor to the trailer.

Workers install the floor covering, furnace, and major plumbing fixtures before they attach the walls to the floor. Exterior walls are pre-assembled, with interior paneling or drywall attached to the wall framing. Then a crane places the wall assemblies on the floor.

Workers build the roof assembly, including ceiling and roof trusses separately. Later, they place the roof on top of the walls and fasten it in place.

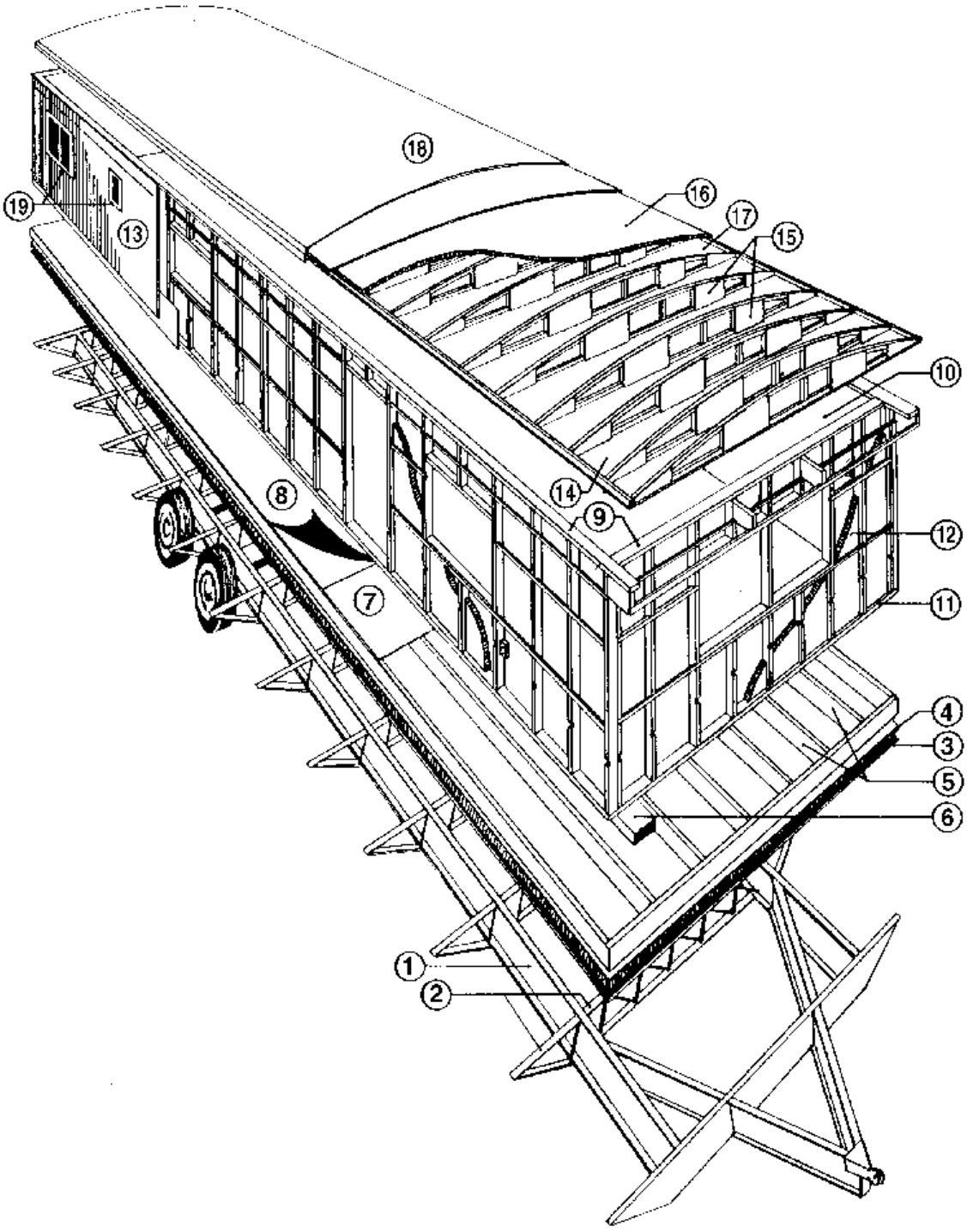
After the roof and walls are wired and insulated, workers install roofing and siding, then windows and doors. Finally, the interior trim work is completed, and the home is transported to its site.

Mobile homes are built in various sizes by more than 100 manufacturers nationwide. Single-wide homes once dominated the market, but now double-wides are more popular. Most currently manufactured mobile homes are at least 14 or 16 feet wide. Older mobile homes are 10 to 14 feet wide. Using 12-to-16–foot-wide sections, double-wide and triple-wide homes reach total widths of 24 to 48 feet. Standard lengths for mobile home sections range from 40 to 80 feet.

Mobile homes: points of weakness — The following list details where air leaks and insulation flaws are most commonly found in mobile homes:

- Joints and holes in forced-air distribution systems.
- Torn or missing belly paper.
- Joints between the halves of double-section homes; around the perimeter of each section — floor, walls, and ceiling.
- Plumbing penetrations in: interior walls, external water heater closets, under bathtubs, behind washing machines, and under sinks.
- Joints between the main structure and building additions.

Mobile Home Construction Characteristics



Typical Components of a Mobile Home: 1–Steel chassis. 2–Steel outriggers and cross members. 3–Underbelly. 4–Fiberglass insulation. 5–Floor joists. 6–Heating/air conditioning duct. 7–Decking. 8–Floor covering. 9–Top plate. 10–Interior paneling. 11–Bottom plate. 12–Fiberglass insulation. 13–Metal siding. 14–Ceiling board. 15–Bowstring trusses. 16–Fiberglass insulation. 17–Vapor barrier. 18–Galvanized steel one-piece roof. 19–Metal windows.