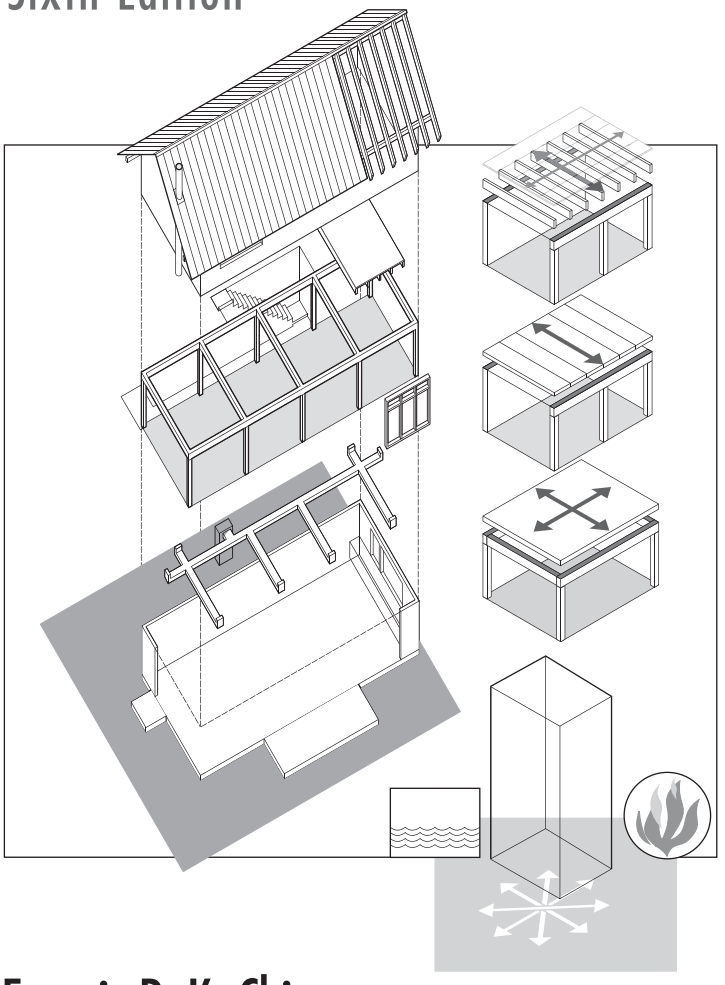
Building Construction Illustrated

Sixth Edition



Francis D. K. Ching

WILEY

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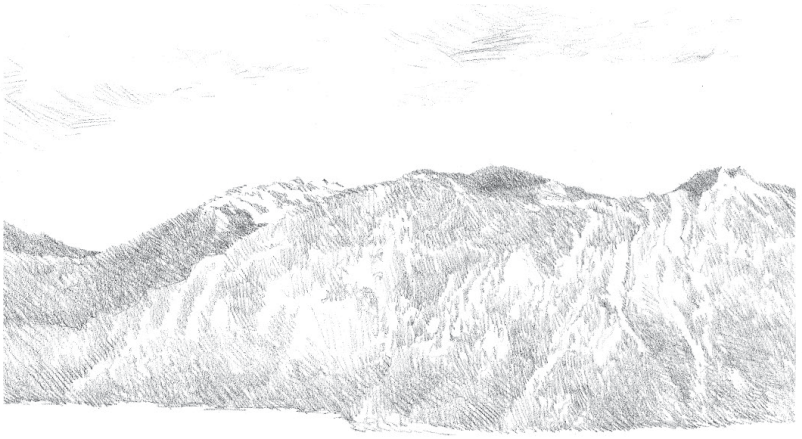
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THE BUILDING SITE

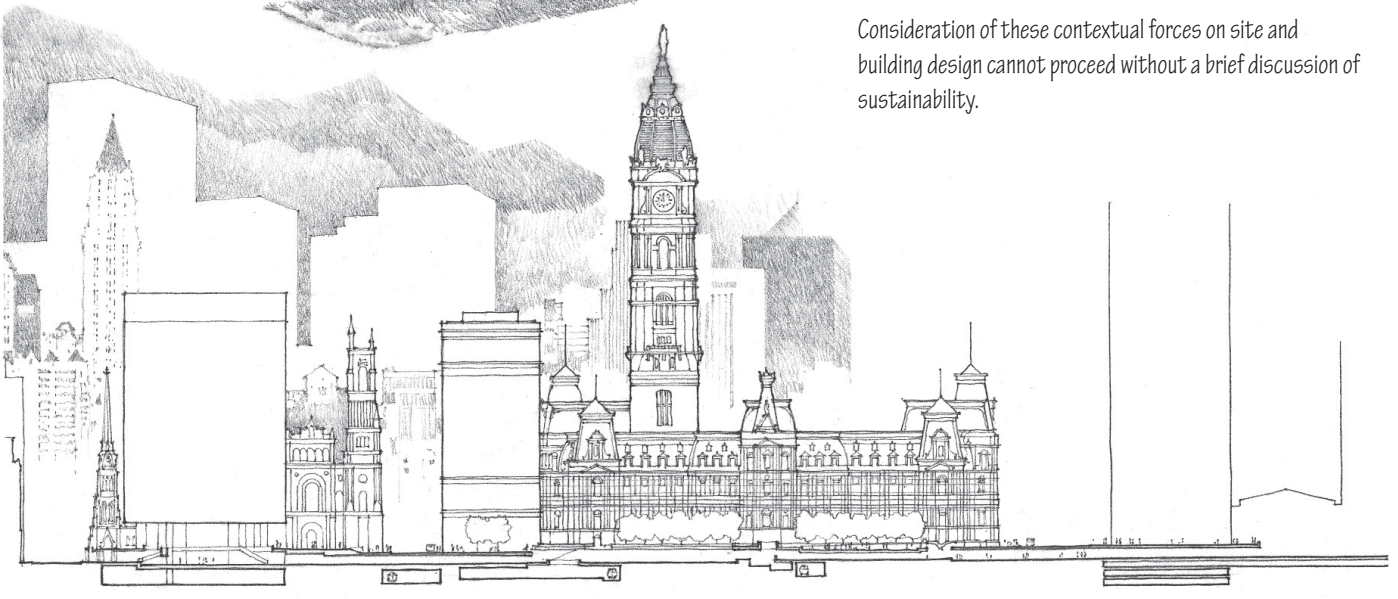
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1.02 BUILDING IN CONTEXT









Buildings do not exist in isolation. They are conceived to house, support, and inspire a range of human activities in response to sociocultural, economic, and political needs, and are erected in natural and built environments that constrain as well as offer opportunities for development. We should therefore carefully consider the contextual forces that a site presents in planning the design and construction of buildings.

The microclimate, topography, and natural habitat of a site all influence design decisions at a very early stage in the design process. To enhance human comfort as well as conserve energy and material resources, responsive and sustainable design respects the indigenous qualities of a place, adapts the form and layout of a building to the landscape, and takes into account the path of the sun, the rush of the wind, and the flow of water on a site.

In addition to environmental forces, there exist the regulatory forces of zoning ordinances. These regulations take into account existing land-use patterns and prescribe the acceptable uses and activities for a site as well as limit the size and shape of the building mass and where it may be located on the site.

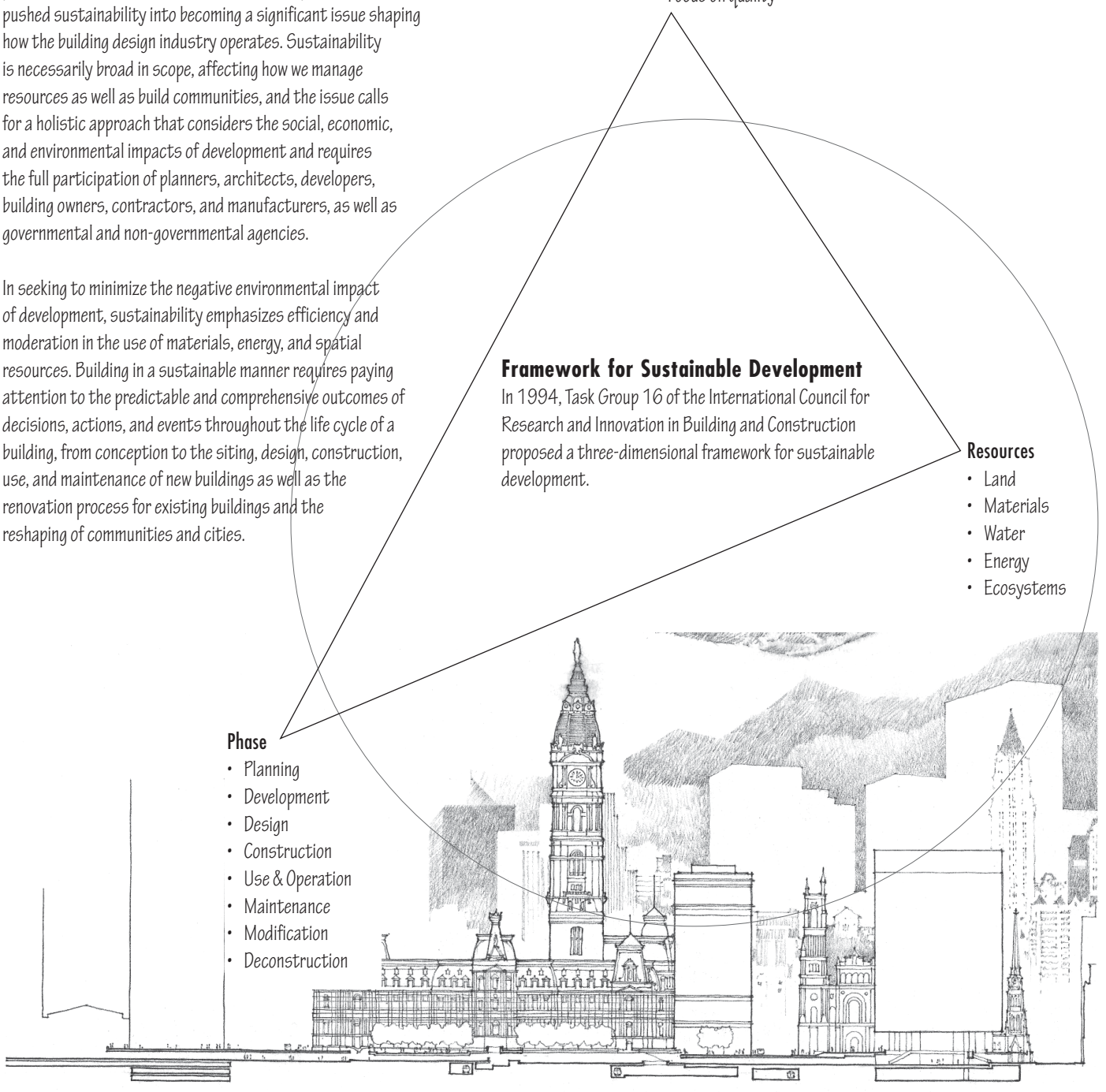
Just as environmental and regulatory factors influence where and how development occurs, the construction, use, and maintenance of buildings inevitably place a demand on transportation systems, utilities, and other services. A fundamental question we face is how much development a site can sustain without exceeding the capacity of these service systems, consuming too much energy, or causing environmental damage.

Consideration of these contextual forces on site and building design cannot proceed without a brief discussion of sustainability.

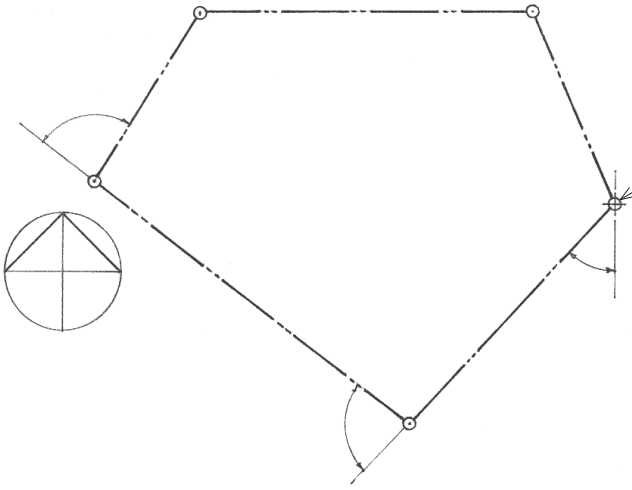
In 1987, the United Nations World Commission on Environment and Development, chaired by Gro Harlem Brundtland, former Prime Minister of Norway, issued a report, *Our Common Future*. Among its findings, the report defined sustainable development as "a form of development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Increasing awareness of the environmental challenges presented by climate change and resource depletion has pushed sustainability into becoming a significant issue shaping how the building design industry operates. Sustainability is necessarily broad in scope, affecting how we manage resources as well as build communities, and the issue calls for a holistic approach that considers the social, economic, and environmental impacts of development and requires the full participation of planners, architects, developers, building owners, contractors, and manufacturers, as well as governmental and non-governmental agencies.

In seeking to minimize the negative environmental impact of development, sustainability emphasizes efficiency and moderation in the use of materials, energy, and spatial resources. Building in a sustainable manner requires paying attention to the predictable and comprehensive outcomes of decisions, actions, and events throughout the life cycle of a building, from conception to the siting, design, construction, use, and maintenance of new buildings as well as the renovation process for existing buildings and the reshaping of communities and cities.

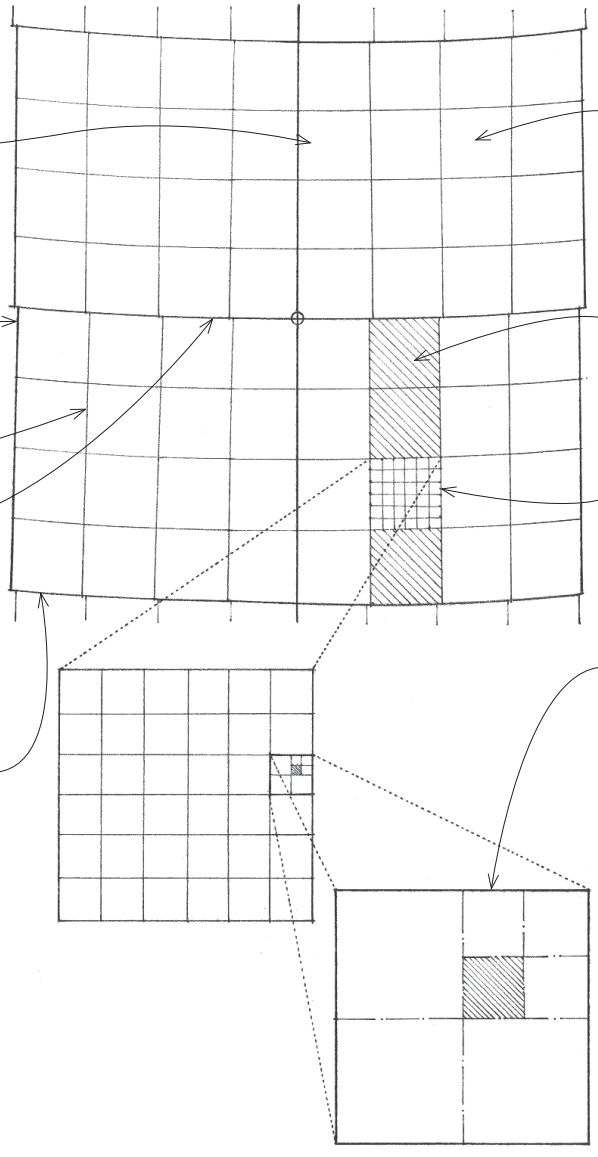


1.42 SITE DESCRIPTION



A legal description of a site consists of the location and boundaries of a specific parcel of land, based on a metes-and-bounds survey or a rectangular system of survey, or made with reference to a recorded plat.

- A metes-and-bounds survey calls out the course and length of each boundary line of a parcel of land, starting at a known reference point and working around the periphery of the plat until returning to the place of beginning.
- A survey plat is a legal document describing the location, boundaries, and dimensions of a tract or parcel of land, including zoning and planning commission approvals, easements and restrictions, and, for a subdivision, the dividing lines of street, blocks, and lots, and the numbering and dimensions of each lot.

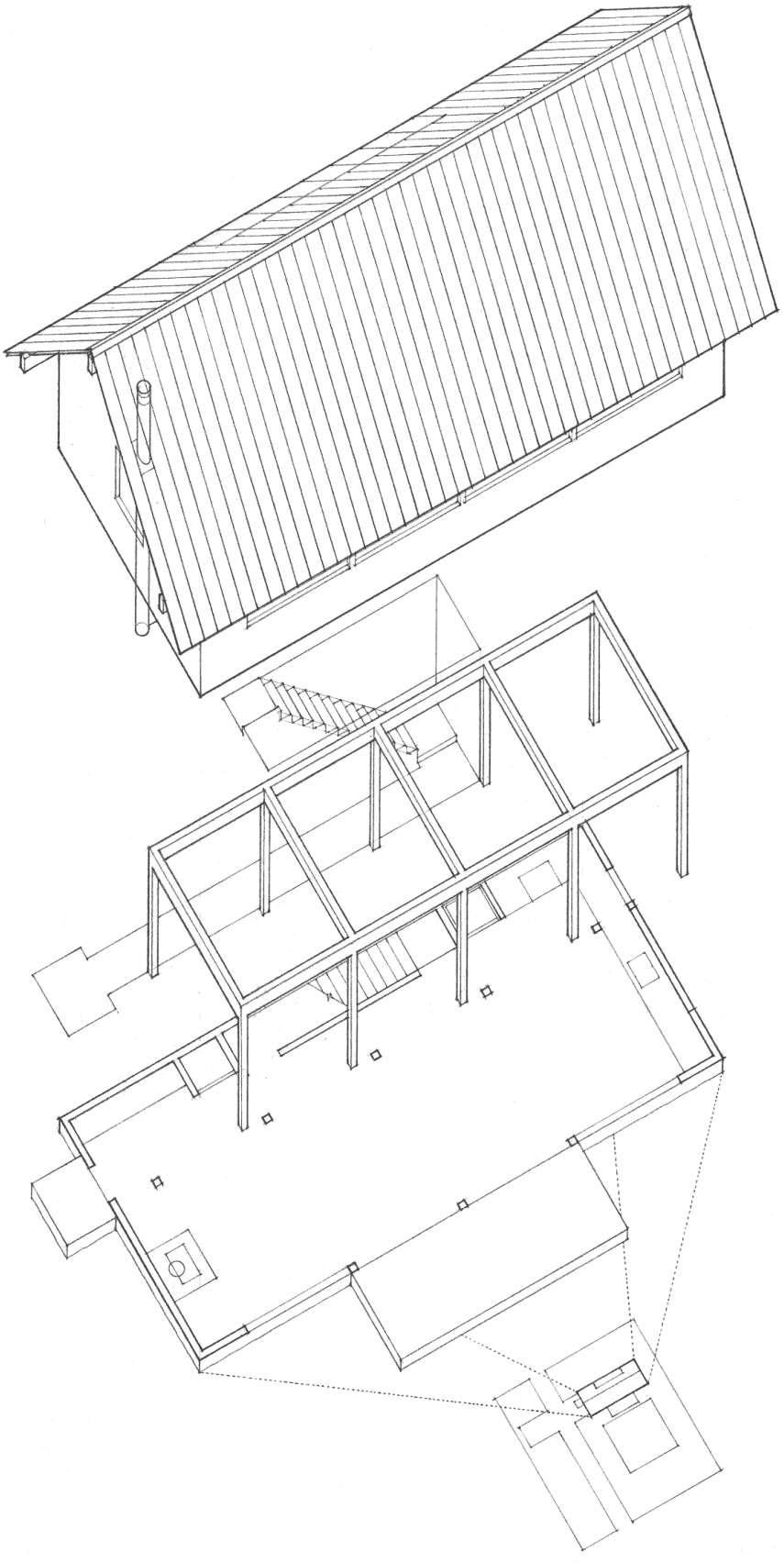


- Principal meridians are north-south reference lines established at substantial landmarks for large areas of land.
- Guide meridians are north-south reference lines located between correction lines at 24-mile (38.62-km) intervals to the east and west of principal meridians.
- Range lines are north-south reference lines located at 6-mile (9.66-km) intervals between guide meridians.
- East-west baseline
- Correction lines are east-west reference lines located at 24-mile (38.62-km) intervals to the north and south of a baseline to correct for the convergence of meridians and equalize east-west distances.

- The rectangular system of survey is based on a modified grid of north-south principal and guide meridians and east-west baselines.
- Range is one of a series of divisions numbered east or west from a guide meridian and consisting of a row of townships that are numbered north or south from a baseline.
- Township is a unit of land area, approximately six miles square (93.2 km^2) containing 36 sections.
- Section is one of the 36 numbered subdivisions of a township, each approximately one square mile (2.59 km^2 or 640 acres) and further subdivided into halves, quarters, and quarter-quarters.

2
THE BUILDING

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Architecture and building construction are not necessarily one and the same thing. An understanding of the methods for assembling various materials, elements, and components is necessary during both the design and the construction of a building. This understanding, however, while it enables one to build architecture, does not guarantee it. A working knowledge of building construction is only one of several critical factors in the execution of architecture. When we speak of architecture as the art of building, we should consider the following conceptual systems of order in addition to the physical ones of construction:

- The definition, scale, proportion, and organization of the interior spaces of a building
- The ordering of human activities by their scale and dimension
- The functional zoning of the spaces of a building according to purpose and use
- Access to the horizontal and vertical paths of movement through the interior of a building
- The sensible qualities of a building: form, space, light, color, texture, and pattern
- The building as an integrated component within the natural and built environment

Of primary interest to us in this book are the physical systems that define, organize, and reinforce the perceptual and conceptual ordering of a building.

A system can be defined as an assembly of interrelated or interdependent parts forming a more complex and unified whole and serving a common purpose. A building can be understood to be the physical embodiment of a number of systems and subsystems that must necessarily be related, coordinated, and integrated with each other as well as with the three-dimensional form and spatial organization of the building as a whole.

Structural System

The structural system of a building is designed and constructed to support and transmit applied gravity and lateral loads safely to the ground without exceeding the allowable stresses in its members.

- The superstructure is the vertical extension of a building above the foundation.
- Columns, beams, and loadbearing walls support floor and roof structures.
- The substructure is the underlying structure forming the foundation of a building.

Enclosure System

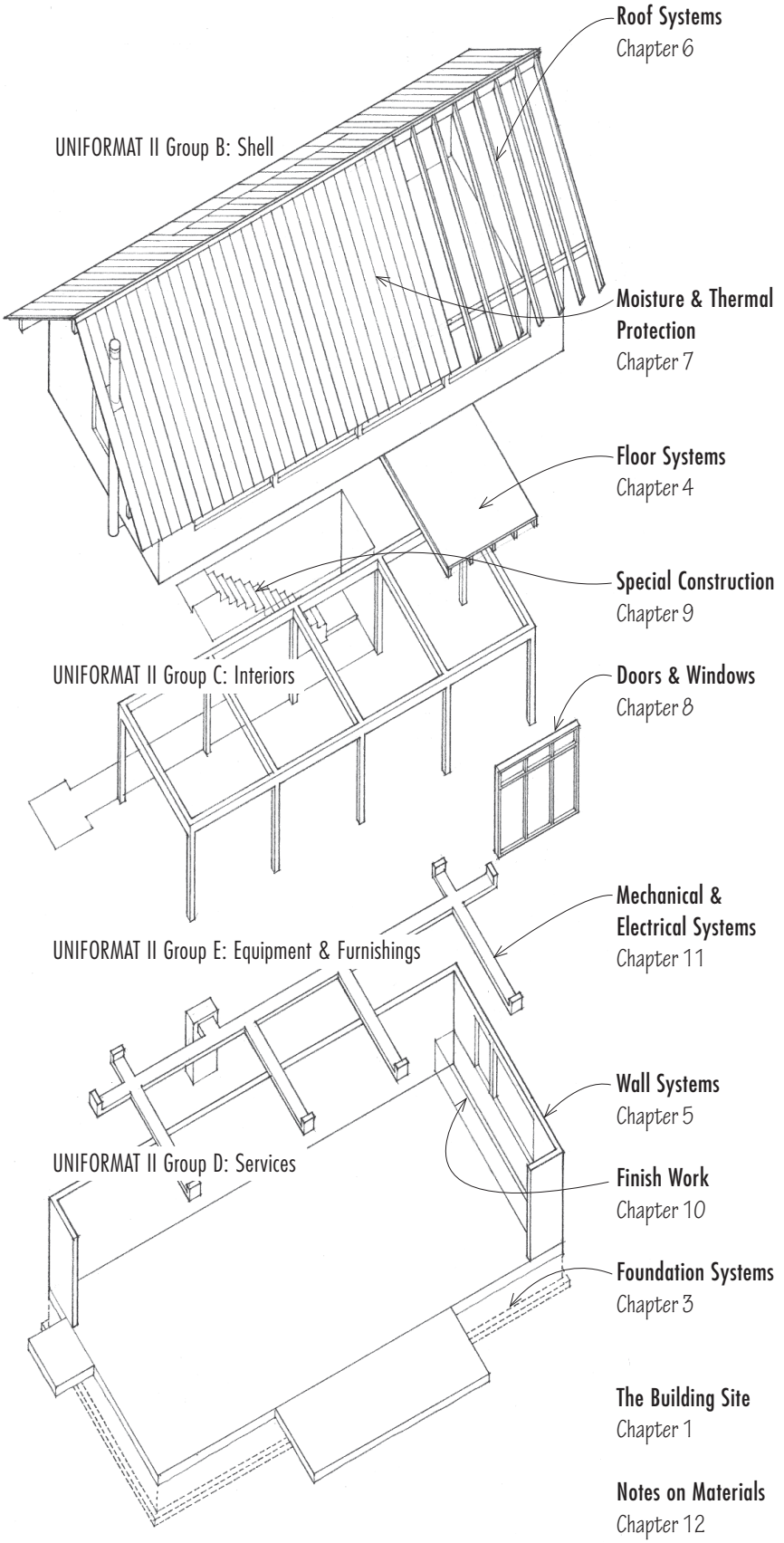
The enclosure system is the shell or envelope of a building, consisting of the roof, exterior walls, windows, and doors.

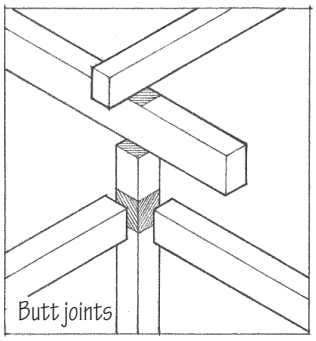
- The roof and exterior walls shelter interior spaces from inclement weather and control moisture, heat, and air flow through the layering of construction assemblies.
- Exterior walls and roofs also dampen noise and provide security and privacy for the occupants of a building.
- Doors provide physical access.
- Windows provide access to light, air, and views.
- Interior walls and partitions subdivide the interior of a building into spatial units.

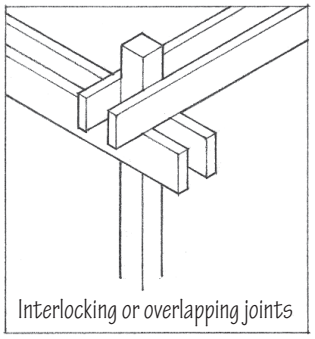
Mechanical Systems

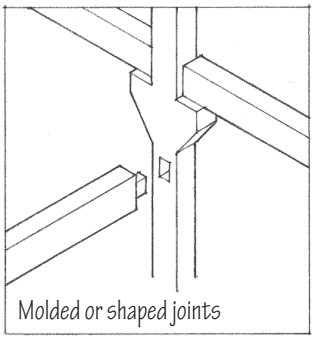
The mechanical systems of a building provide essential services to a building.

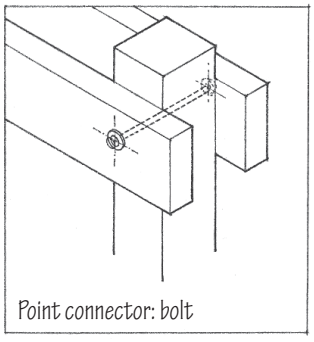
- The water supply system provides potable water for human consumption and sanitation.
- The sewage disposal system removes fluid waste and organic matter from a building.
- Heating, ventilating, and air-conditioning systems condition the interior spaces of a building for the environmental comfort of the occupants.
- The electrical system controls, meters, and protects the electric power supply to a building, and distributes it in a safe manner for power, lighting, security, and communication systems.
- Vertical transportation systems carry people and goods from one level to another in medium- and high-rise buildings.
- Firefighting systems detect and extinguish fires.
- Structures may also require waste disposal and recycling systems.

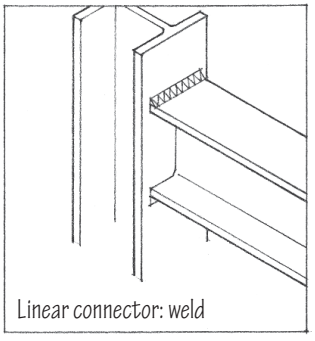


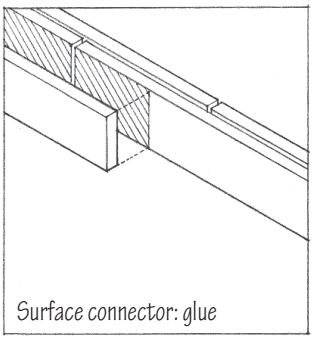

Butt joints

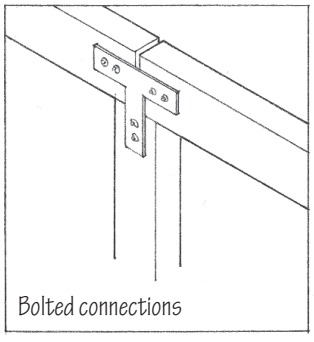

Interlocking or overlapping joints

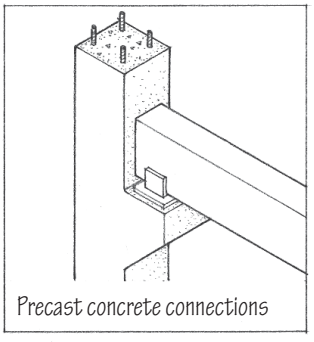

Molded or shaped joints

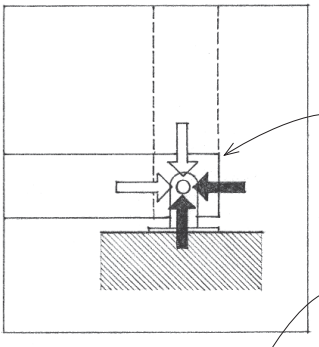

Point connector: bolt

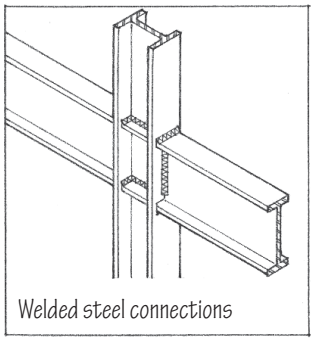

Linear connector: weld

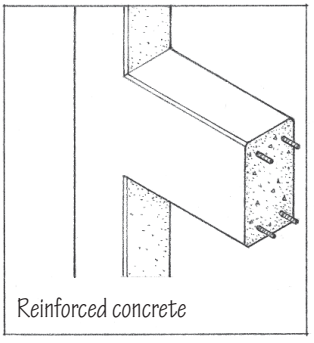

Surface connector: glue

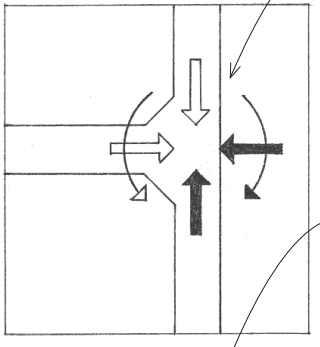

Bolted connections

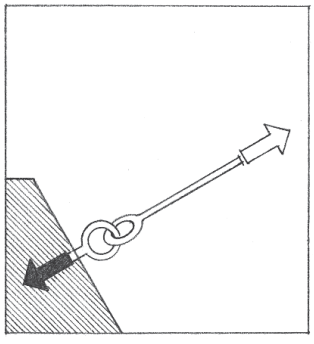

Precast concrete connections

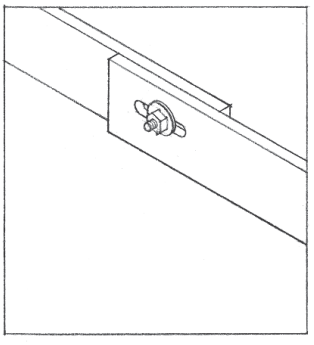


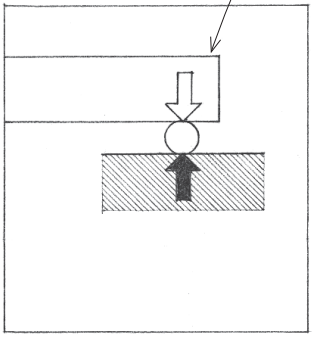

Welded steel connections


Reinforced concrete









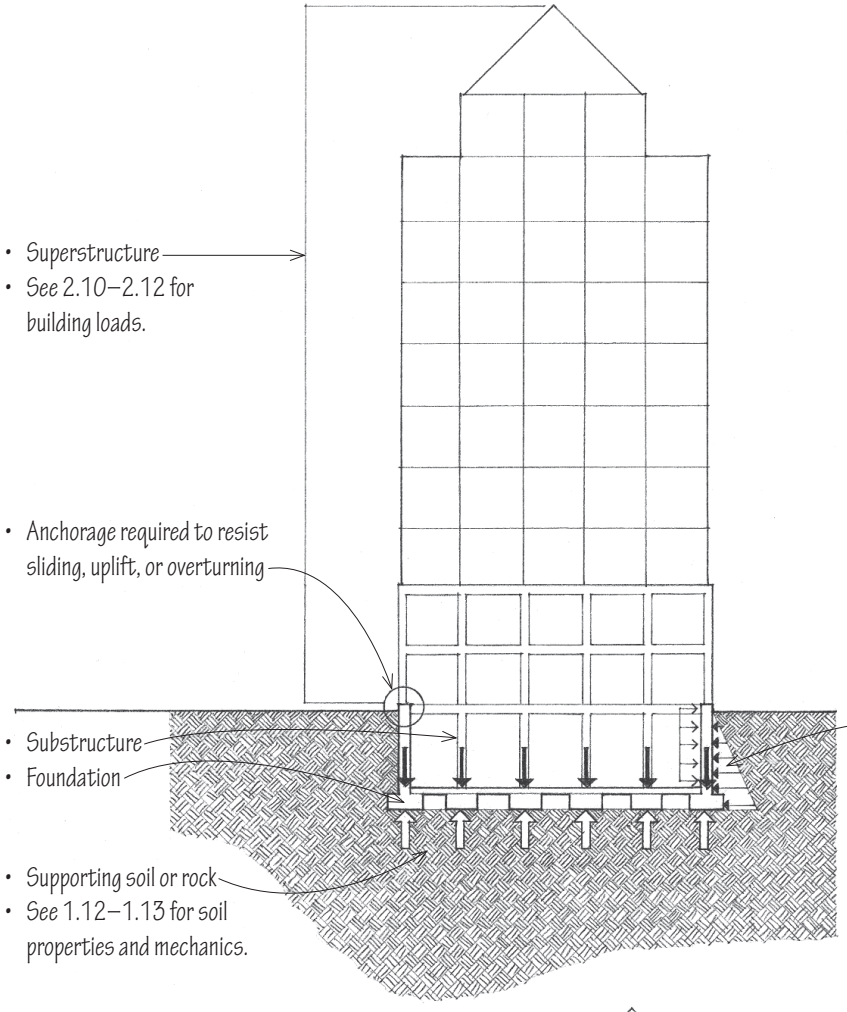
The manner in which forces are transferred from one structural element to the next and how a structural system performs as a whole depend to a great extent on the types of joints and connections used. Structural elements can be joined to each other in three ways. Butt joints allow one of the elements to be continuous and usually require a third mediating element to make the connection. Overlapping joints allow all of the connected elements to bypass each other and be continuous across the joint. The joining elements can also be molded or shaped to form a structural connection.

The connectors used to join the structural elements may be in the form of a point, a line, or a surface. While linear and surface types of connectors resist rotation, point connectors do not unless a series of them is distributed across a large surface area.

- Pinned joints theoretically allow rotation but resist translation in any direction.
- Rigid or fixed joints maintain the angular relationship between the joined elements, restrain rotation and translation in any direction, and provide both force and moment resistance.
- Roller joints allow rotation but resist translation in a direction perpendicular into or away from their faces. They are not employed in building construction as often as pinned or fixed connections but they are useful when a joint must allow expansion and contraction of a structural element to occur.
- A cable anchorage allows rotation but resists translation only in the direction of the cable.

3
FOUNDATION SYSTEMS

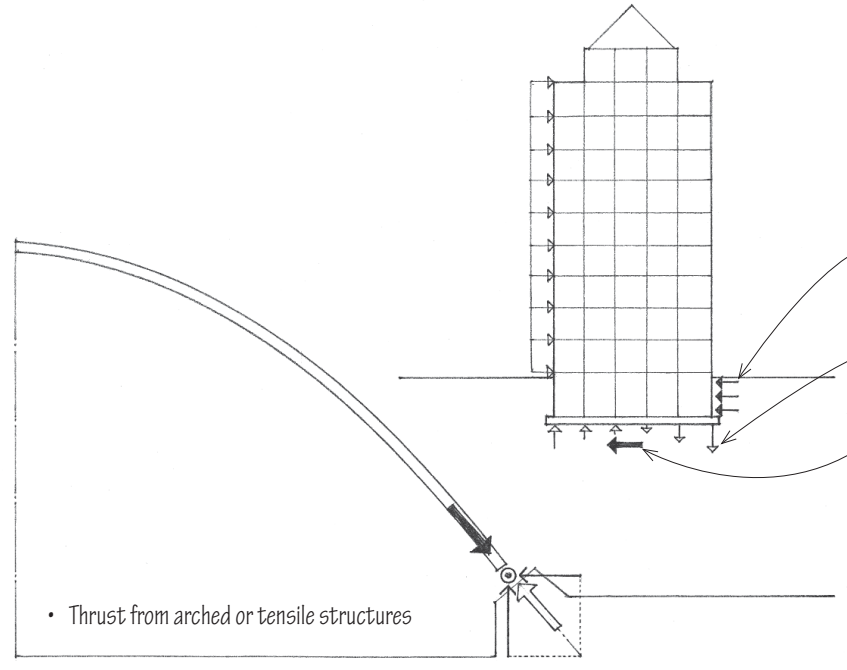
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3.26 Caisson Foundations



The foundation is the lowest division of a building—its substructure—constructed partly or wholly below the surface of the ground. Its primary function is to support and anchor the superstructure above and transmit its loads safely into the earth. Because it serves as a critical link in the distribution and resolution of building loads, the foundation system must be designed to both accommodate the form and layout of the superstructure above and respond to the varying conditions of soil, rock, and water below.

The principal loads on a foundation are the combination of dead and live loads acting vertically on the superstructure. In addition, a foundation system must anchor the superstructure against wind-induced sliding, overturning, and uplift, withstand the sudden ground movements of an earthquake, and resist the pressure imposed by the surrounding soil mass and groundwater on basement walls. In some cases, a foundation system may also have to counter the thrust from arched or tensile structures.

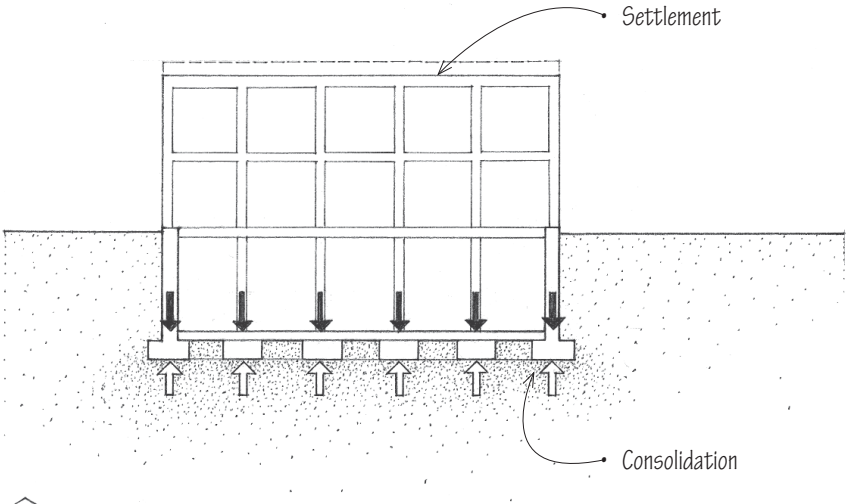
• Active earth pressure exerted by a soil mass on a basement wall



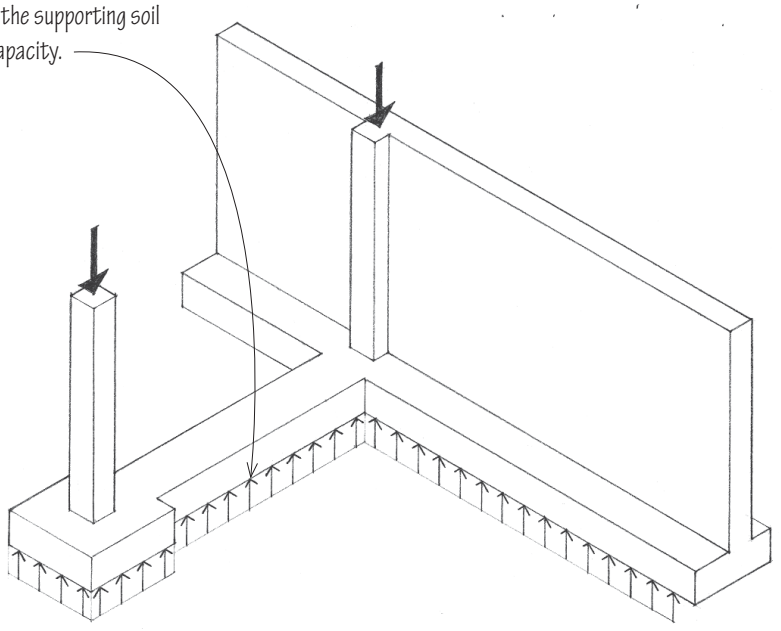
• Passive earth pressure is developed by a soil mass in response to the horizontal movement of a foundation.

• Lateral forces can cause the foundation to impose nonuniform pressure on the supporting soil.
• Some shear resistance is provided by the friction between the foundation and the underlying soil.

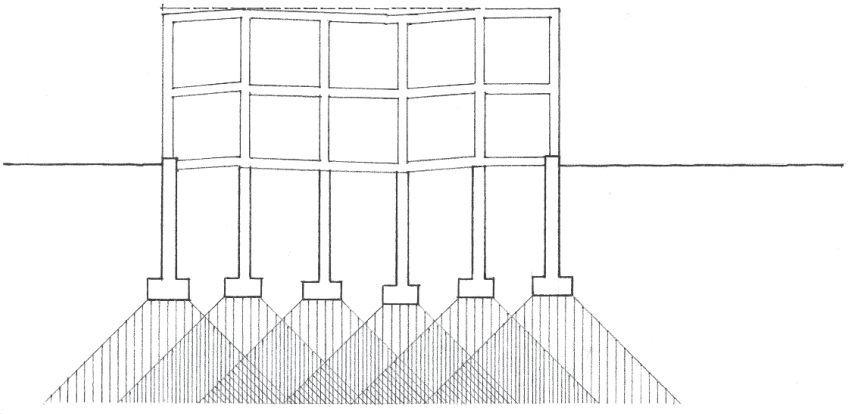
Settlement is the gradual subsiding of a structure as the soil beneath its foundation consolidates under loading. As a building is constructed, some settlement is to be expected as the load on the foundation increases and causes a reduction in the volume of soil voids containing air or water. This consolidation is usually slight and occurs rather quickly as loads are applied on dense, granular soils, such as coarse sand and gravel. When the foundation soil is a moist, cohesive clay, which has a scale-like structure and a relatively large percentage of voids, consolidation can be quite large and occur slowly over a longer period of time.



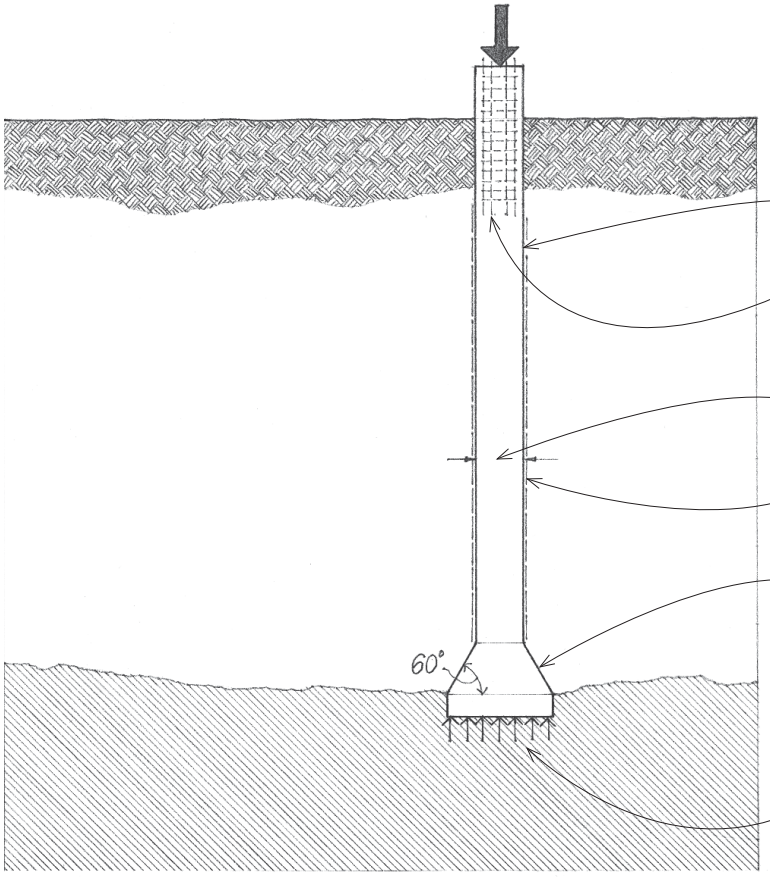
A properly designed and constructed foundation system should distribute its loads so that whatever settlement occurs is minimal or is uniformly distributed under all portions of the structure. This is accomplished by laying out and proportioning the foundation supports so that they transmit an equal load per unit area to the supporting soil or rock without exceeding its bearing capacity.



Differential settlement—the relative movement of different parts of a structure caused by uneven consolidation of the foundation soil—can cause a building to shift out of plumb and cracks to occur in its foundation, structure, or finishes. If extreme, differential settlement can result in the failure of the structural integrity of a building.

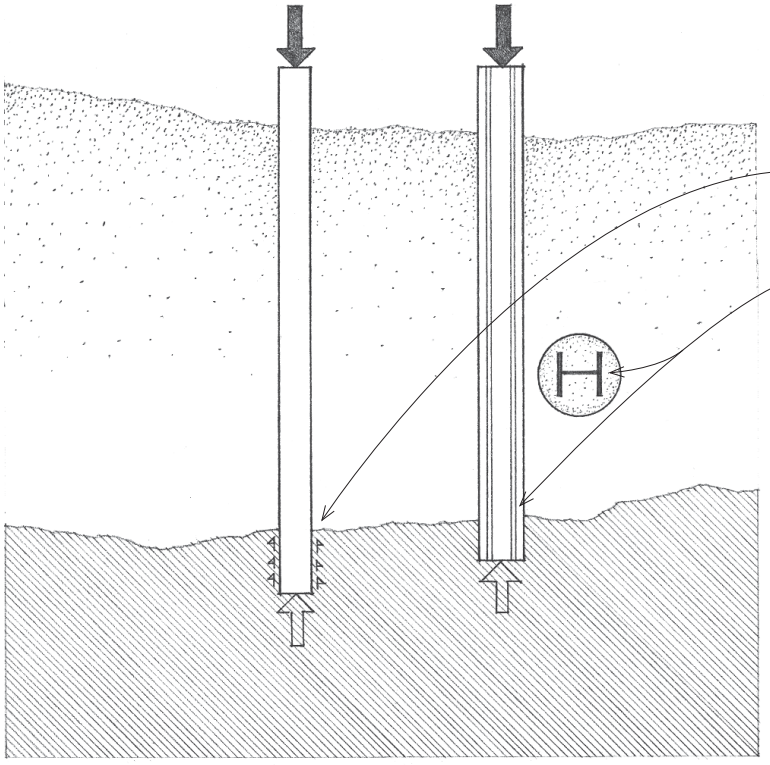


3.26 CAISSON FOUNDATIONS



Caissons are cast-in-place, plain or reinforced concrete piers formed by boring with a large auger or excavating by hand a shaft in the earth to a suitable bearing stratum and filling the shaft with concrete. For this reason, they are also referred to as drilled piles or piers.

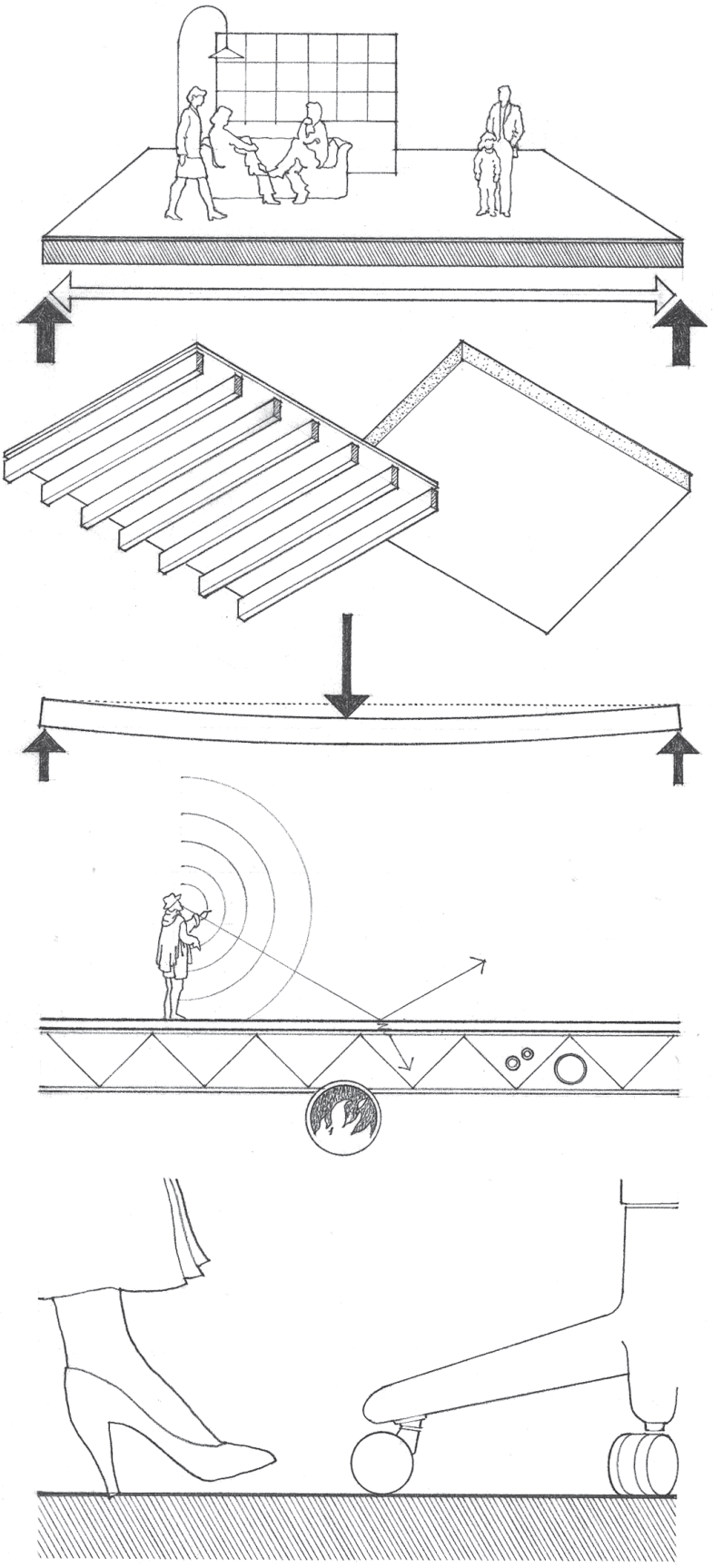
- Caisson
- Reinforcement in upper part of shaft provides additional resistance to bending caused by lateral forces or eccentric column loading.
- The boring is often 2' 6" (760) or larger in diameter to permit inspection of the bottom.
- A temporary casing may be required to seal out water, sand, or loose fill from the shaft during excavation.
- The base of a caisson may be enlarged into a bell shape to increase its bearing area and resist uplift from soil expansion. The bell may be excavated by hand or be formed by a bucket attachment to an earth auger that has a set of retractable blades.
- Suitable bearing stratum of soil or rock



- Socketed caissons are drilled into a stratum of solid rock in order to gain additional frictional support.
- Rock caissons are socketed caissons that have a steel H-section core within a concrete-filled pipe casing.

4
FLOOR SYSTEMS

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4.41 Mass Timber Floors



Floor systems are the horizontal planes that must support both live loads—people, furnishings, and movable equipment—and dead loads—the weight of the floor construction itself. Floor systems must transfer their loads horizontally across space to either beams and columns or to loadbearing walls. Rigid floor planes can also be designed to serve as horizontal diaphragms that act as thin, wide beams in transferring lateral forces to shear walls.

A floor system may be composed of a series of linear beams and joists overlaid with a plane of sheathing or decking, or consist of a nearly homogeneous slab of reinforced concrete. The depth of a floor system is directly related to the size and proportion of the structural bays it must span and the strength of the materials used. The size and placement of any cantilevers and openings within the floor plane should also be considered in the layout of the structural supports for the floor. The edge conditions of the floor structure and its connection to supporting foundation and wall systems affect both the structural integrity of a building and its physical appearance.

Because it must safely support moving loads, a floor system should be relatively stiff while maintaining its elasticity. Due to the detrimental effects that excessive deflection and vibration would have on finish flooring and ceiling materials, as well as concern for human comfort, deflection rather than bending becomes the critical controlling factor.

The depth of the floor construction and the cavities within it should be considered if it is necessary to accommodate runs of mechanical or electrical lines within the floor system. For floor systems between habitable spaces stacked one above another, additional factors to consider are the blockage of both airborne and structure-borne sound and the fire-resistance rating of the assembly.

Except for exterior decks, floor systems are not normally exposed to weather. Because they all must support traffic, however, durability, resistance to wear, and maintenance requirements are factors to consider in the selection of a floor finish and the system required to support it.

Concrete Floor Structures

- Cast-in-place concrete floor slabs are classified according to their span and cast form; see 4.05–4.07.
- Precast concrete planks may be supported by beams or loadbearing walls.

Steel Floor Structures

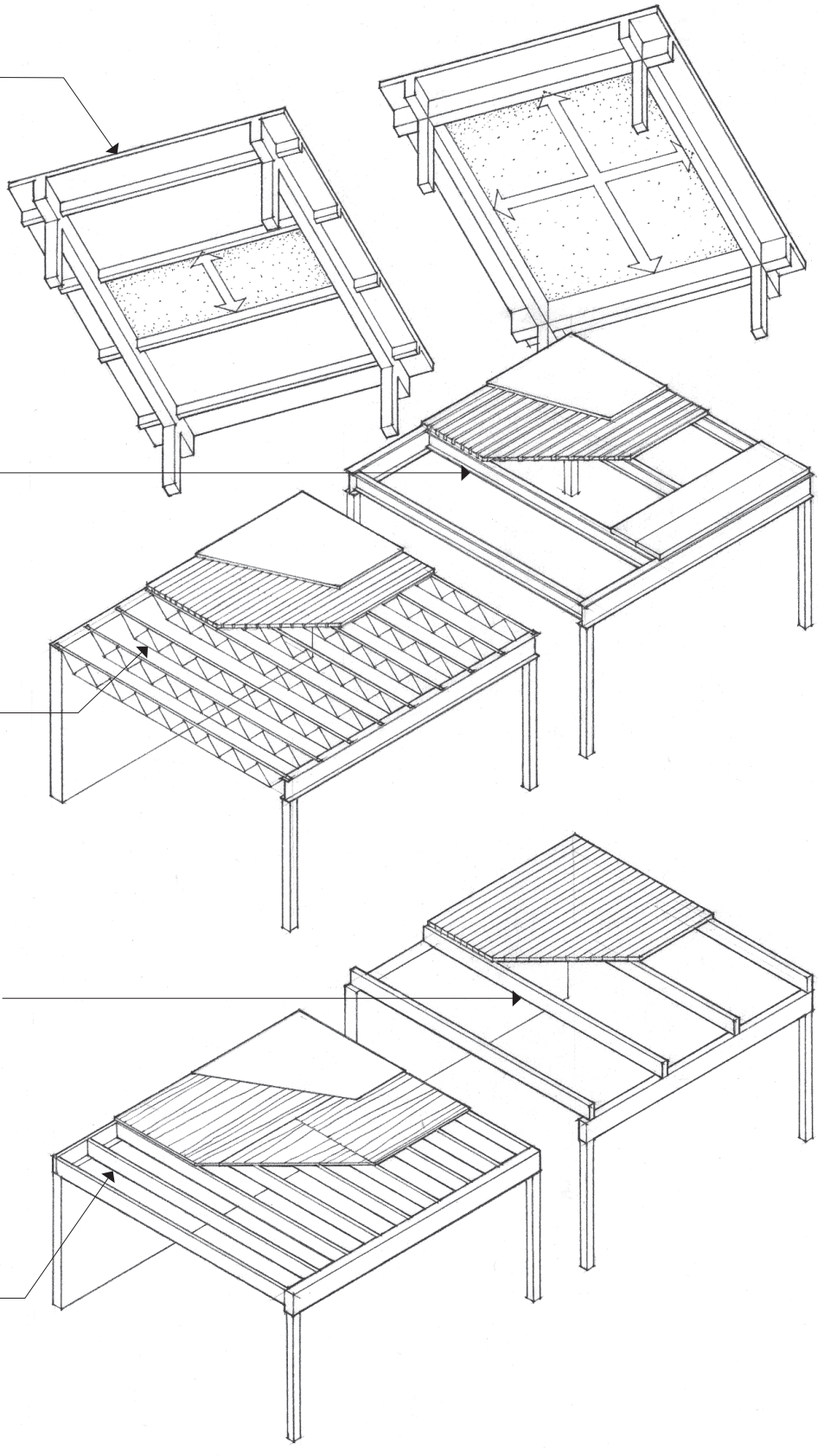
- Steel beams support steel decking or precast concrete planks.
- Beams may be supported by girders, columns, or loadbearing walls.
- Beam framing is typically an integral part of a steel skeleton frame system.

- Closely spaced light-gauge or open-web joists may be supported by beams or loadbearing walls.
- Steel decking or wood planks have relatively short spans.
- Joists have limited overhang potential.

Wood Floor Structures

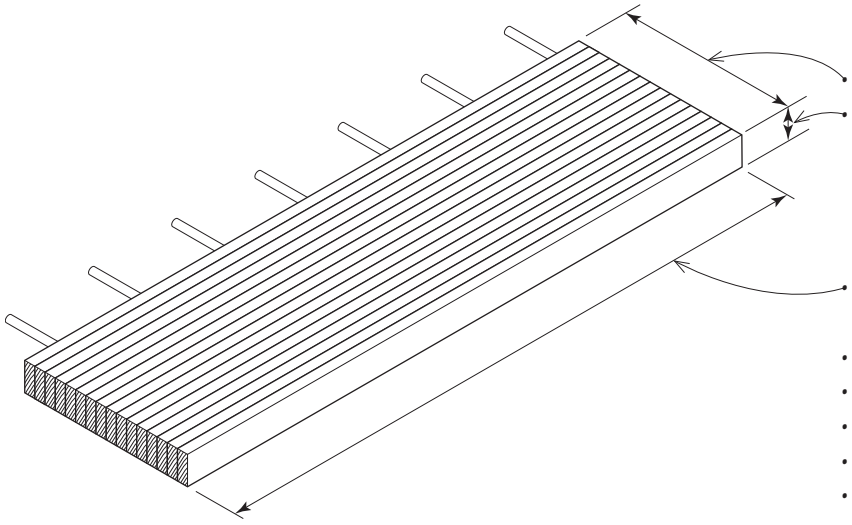
- Wood beams support structural planking, decking, or panels
- Beams may be supported by girders, posts, or loadbearing walls.
- Concentrated loads and floor openings may require additional framing.
- Underside of floor structure may be left exposed; an applied ceiling is optional.

- Relatively small, closely spaced joists may be supported by beams or loadbearing walls.
- Subflooring, underlayment, and applied ceiling finishes have relatively short spans.
- Joist framing is flexible in shape and form.



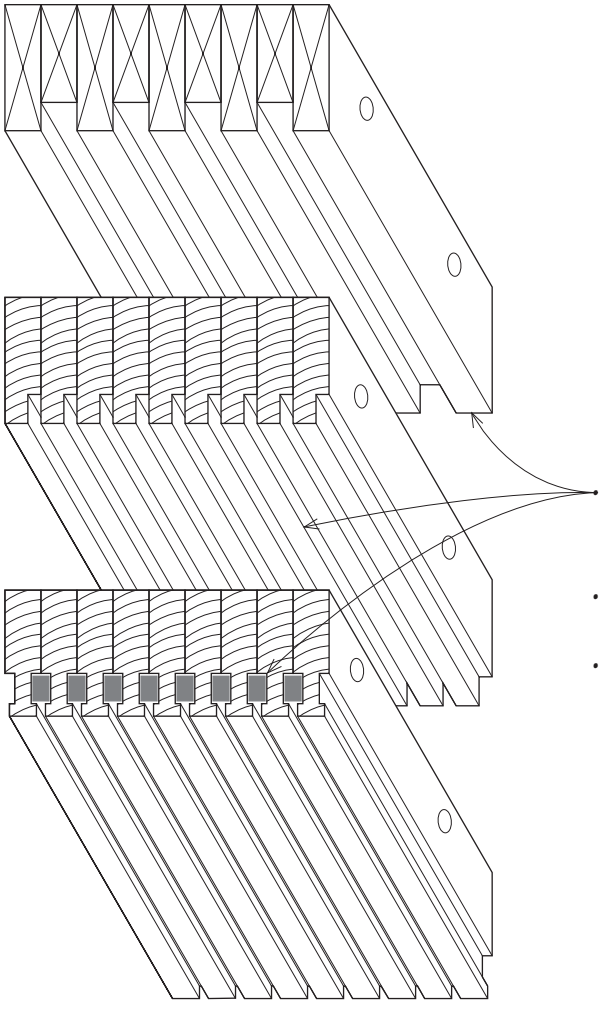
Dowel-Laminated Timber

Dowel-Laminated Timber (DLT) is made by placing 2× dimension lumber on edge (like NLT) and friction-fitting together with wood dowels.



- Up to 12' (3660) wide
- 3 1/2"–14" (90–355) thick
- Up to 60' (18 290) long

- 2 × 4s on edge can span from 10' to 12' (3050 to 3660).
- 2 × 6s on edge can span from 12' to 16' (3660 to 4875).
- 2 × 8s on edge can span from 16' to 20' (4875 to 6095).
- 2 × 10s on edge can span from 20' to 26' (6095 to 7925).
- 2 × 12s on edge can span from 26' to 30' (7925 to 9145).

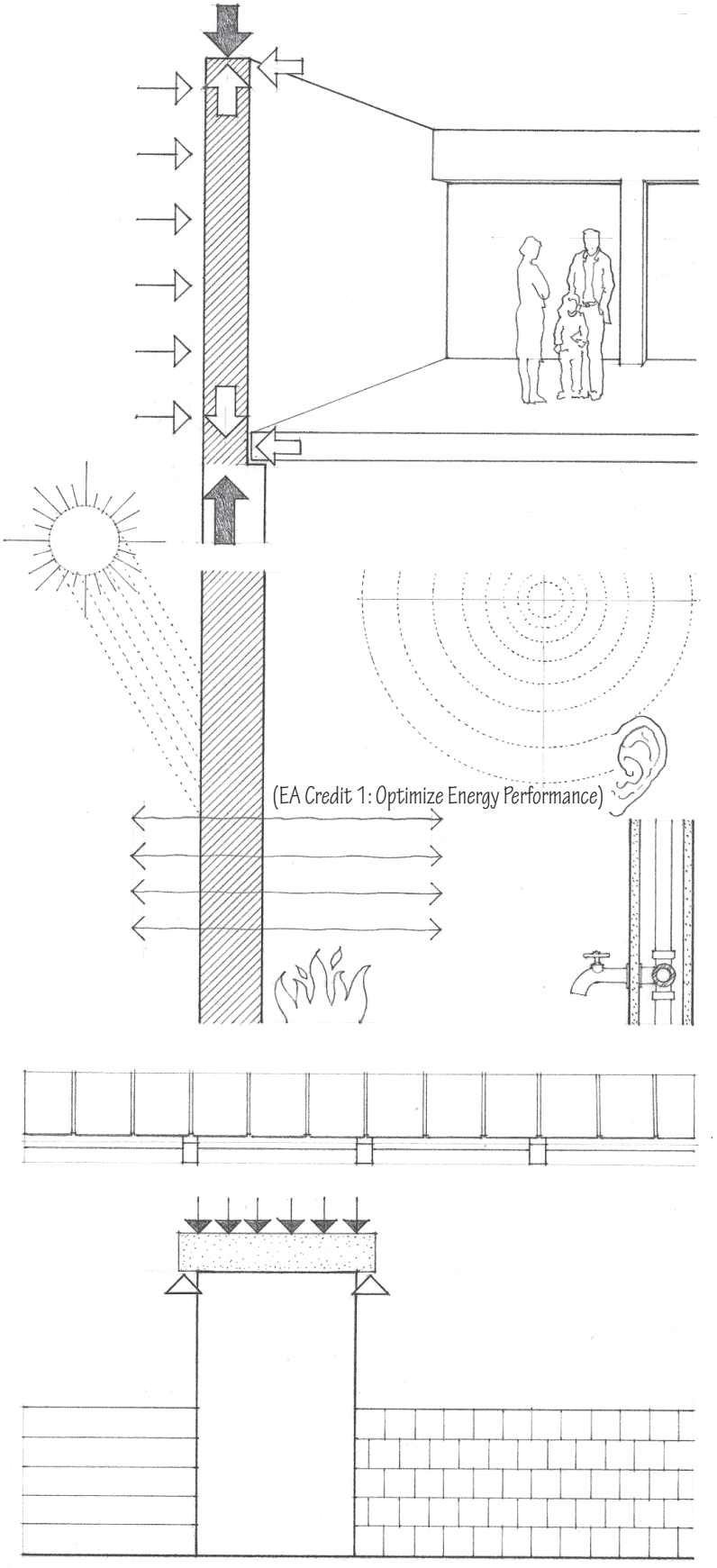


- Variety of profiles available, including acoustic profiles using noncombustible, fibrous insulation to absorb sound.

- 2-way spanning action possible with multiple layers of plywood applied to top of panels.
- Timber-concrete composite technology optimizes structural performance and improves acoustic separation between floors.

5
WALL SYSTEMS

5.02 Wall Systems
5.04 Concrete Columns
5.06 Concrete Walls
5.07 Concrete Formwork
5.09 Concrete Surfacing
5.10 Precast Concrete Walls
5.11 Precast Concrete Wall Panels & Columns
5.12 Precast Concrete Connections
5.13 Tilt-Up Construction
5.14 Masonry Walls
5.16 Unreinforced Masonry Walls
5.18 Reinforced Masonry Walls
5.19 Masonry Columns & Pilasters
5.20 Masonry Arches
5.21 Masonry Lintels
5.22 Expansion & Control Joints
5.23 Masonry Wall Sections
5.26 Masonry Bonding
5.28 Structural Clay Tile
5.29 Glass Block
5.31 Adobe Construction
5.32 Rammed-Earth Construction
5.33 Stone Masonry
5.35 Structural Steel Framing
5.37 Steel Columns
5.39 Light-Gauge Steel Studs
5.40 Light-Gauge Stud Framing
5.41 Balloon Framing
5.42 Platform Framing
5.43 Wood Stud Framing
5.46 Stud Wall Sheathing
5.47 Wood Columns
5.48 Wood Post-and-Beam Framing
5.49 Wood Post-Beam Connections
5.51 Cross-Laminated Timber Walls



Walls are the vertical constructions of a building that enclose, separate, and protect its interior spaces. They may be loadbearing structures of homogeneous or composite construction designed to support imposed loads from floors and roofs, or consist of a framework of columns and beams with nonstructural panels attached to or filling in between them. The pattern of these loadbearing walls and columns should be coordinated with the layout of the interior spaces of a building.

In addition to supporting vertical loads, exterior wall constructions must be able to withstand horizontal wind loading. If rigid enough, they can serve as shear walls and transfer lateral wind and seismic forces to the ground foundation.

Because exterior walls serve as a protective shield against the weather for the interior spaces of a building, their construction should control the passage of heat, infiltrating air, sound, moisture, and water vapor. The exterior skin, which may be either applied to or integral with the wall structure, should be durable and resistant to the weathering effects of sun, wind, and rain. Building codes specify the fire-resistance rating of exterior walls, loadbearing walls, and interior partitions.

The interior walls or partitions, which subdivide the space within a building, may be either structural or non-load-bearing. Their construction should be able to support the desired finish materials, provide the required degree of acoustical separation, and accommodate when necessary the distribution and outlets of mechanical and electrical services.

Openings for doors and windows must be constructed so that any vertical loads from above are distributed around the openings and not transferred to the door and window units themselves. Their size and location are determined by the requirements for natural light, ventilation, view, and physical access, as well as the constraints of the structural system and modular wall materials.

Structural Frames

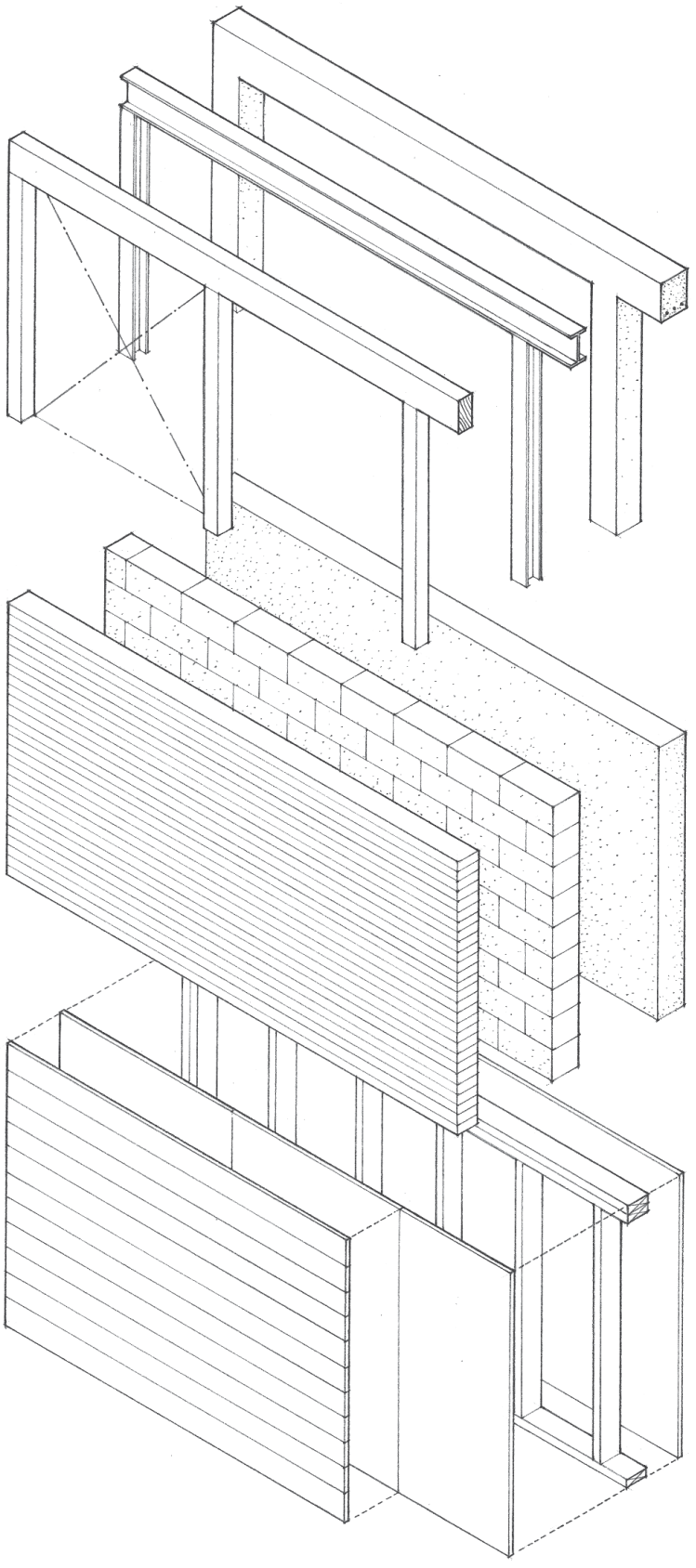
- Concrete frames are typically rigid frames and qualify as noncombustible, fire-resistive construction.
- Noncombustible steel frames may utilize moment connections and require fireproofing to qualify as fire-resistive construction.
- Timber frames require diagonal bracing or shear planes for lateral stability and may qualify as heavy timber construction if used with noncombustible, fire-resistive exterior walls and if the members meet the minimum size requirements specified in the building code.
- Steel and concrete frames are able to span greater distances and carry heavier loads than timber structures.
- Structural frames can support and accept a variety of nonbearing or curtain wall systems.
- The detailing of connections is critical for structural and visual reasons when the frame is left exposed.

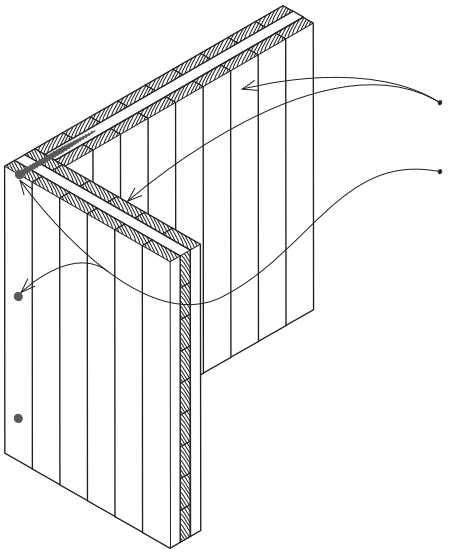
Concrete and Masonry Bearing Walls

- Concrete and masonry walls qualify as noncombustible construction and rely on their mass for their load-carrying capability.
- While strong in compression, concrete and masonry require reinforcing to handle tensile stresses.
- Height-to-width ratio, provisions for lateral stability, and proper placement of expansion joints are critical factors in wall design and construction.
- Wall surfaces may be left exposed.

Metal and Wood Stud Walls

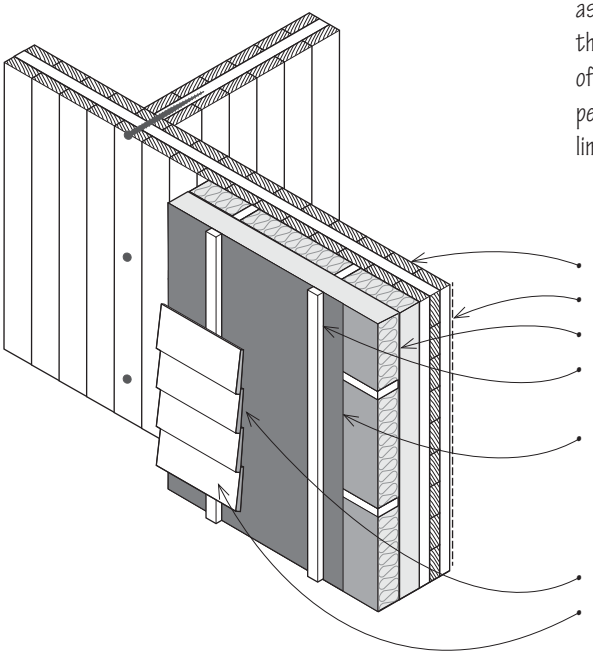
- Studs of cold-formed metal or wood are normally spaced @ 16" or 24" (406 or 610) o.c.; this spacing is related to the width and length of common sheathing materials.
- Studs carry vertical loads while sheathing or diagonal bracing stiffens the plane of the wall.
- Cavities in the wall frame can accommodate thermal insulation, vapor retarders, and mechanical distribution and outlets of mechanical and electrical services.
- Stud framing can accept a variety of interior and exterior wall finishes; some finishes require a nail-base sheathing.
- The finish materials determine the fire-resistance rating of the wall assembly.
- Stud wall frames may be assembled on site or panelized off site.
- Stud walls are flexible in form due to the workability of relatively small pieces and the various means of fastening available.





Examples of Panel-to-Panel Connections

Because CLT panels are not intended to be exposed to the exterior environment, the design of exterior wall and roof assemblies should aim to keep the panels dry and prevent the accumulation of trapped moisture. Consider the use of overhangs and well-ventilated rain screens to prevent penetration of liquid moisture and integrating air barriers to limit the passage of airborne moisture.

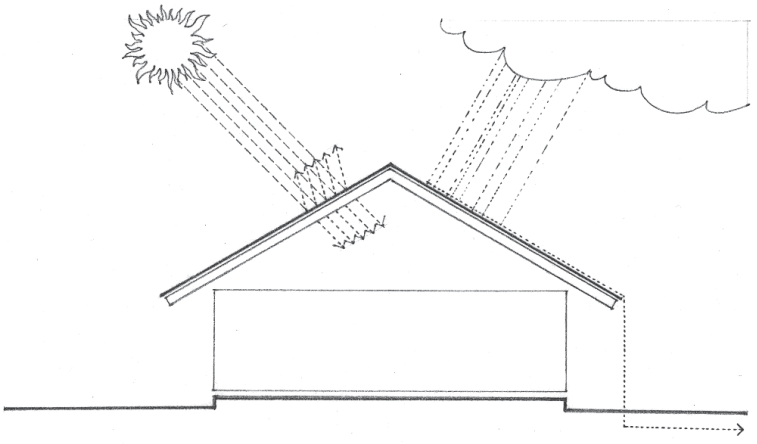


Example of an Exterior Wall Assembly

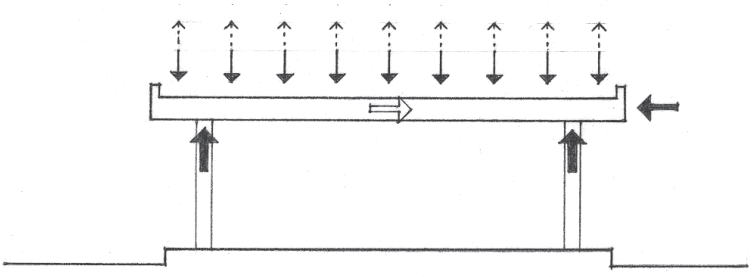
For more information on mass timber products, see 12.15–12.16.

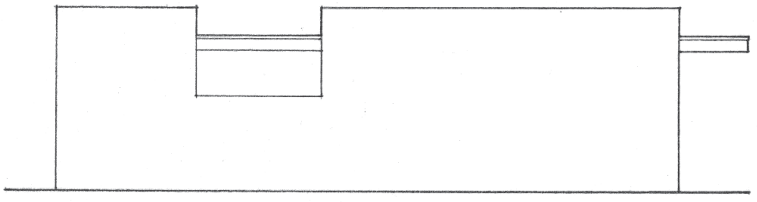
6
ROOF SYSTEMS

6.02 Roof Systems
6.03 Roof Slopes
6.04 Reinforced Concrete Roof Slabs
6.05 Precast Concrete Roof Systems
6.06 Structural Steel Roof Framing
6.07 Steel Rigid Frames
6.08 Steel Trusses
6.09 Truss Types
6.10 Space Frames
6.12 Open-Web Steel Joists
6.13 Open-Web Joist Framing
6.14 Metal Roof Decking
6.15 Cementitious Roof Planks
6.16 Rafter Framing
6.18 Light-Gauge Roof Framing
6.19 Wood Rafters
6.20 Wood Rafter Framing
6.23 Roof Sheathing
6.24 Wood Plank-and-Beam Framing
6.26 Wood Post-Beam Connections
6.28 Mass Timber Roofs
6.30 Wood Trusses
6.32 Wood Trussed Rafters



EA Credit 1: Optimize Energy Performance



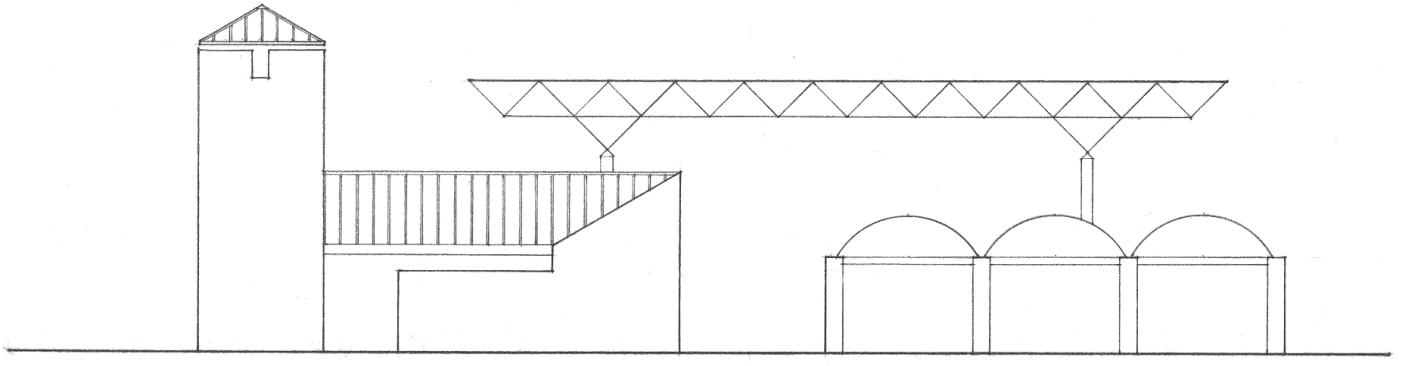


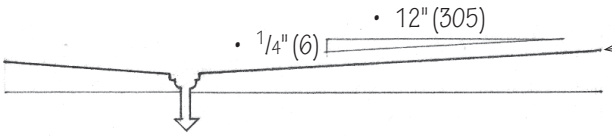
The roof system functions as the primary sheltering element for the interior spaces of a building. The form and slope of a roof must be compatible with the type of roofing—shingles, tiles, or a continuous membrane—used to shed rainwater and melting snow to a system of drains, gutters, and downspouts. The construction of a roof should also control the passage of moisture vapor, the infiltration of air, and the flow of heat and solar radiation. And depending on the type of construction required by the building code, the roof structure and assembly may have to resist the spread of fire.

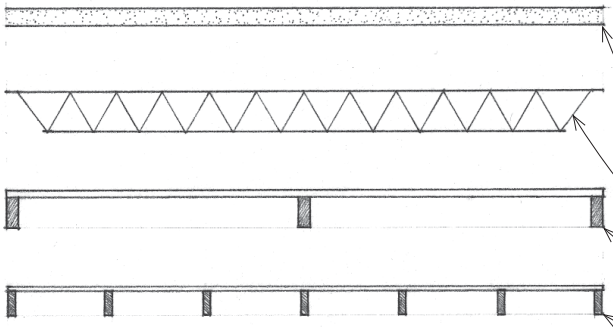
Like floor systems, a roof must be structured to span across space and carry its own weight as well as the weight of any attached equipment and accumulated rain and snow. Flat roofs used as decks are also subject to live occupancy loads. In addition to these gravity loads, the planes of the roof may be required to resist lateral wind and seismic forces, as well as uplifting wind forces, and transfer these forces to the supporting structure.

Because the gravity loads for a building originate with the roof system, its structural layout must correspond to that of the column and bearing wall systems through which its loads are transferred down to the foundation system. This pattern of roof supports and the extent of the roof spans, in turn, influences the layout of interior spaces and the type of ceiling that the roof structure may support. Long roof spans would open up a more flexible interior space while shorter roof spans might suggest more precisely defined spaces.

The form of a roof structure—whether flat or pitched, gabled or hipped, broad and sheltering, or rhythmically articulated—has a major impact on the image of a building. The roof may be exposed with its edges flush with or overhanging the exterior walls, or it may be concealed from view, hidden behind a parapet. If its underside remains exposed, the roof also transmits its form to the upper boundaries of the interior spaces below.



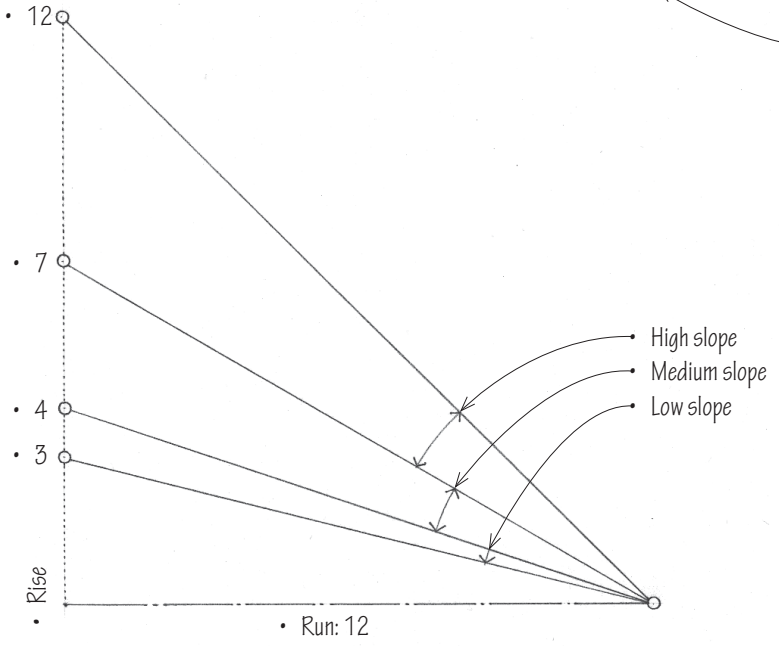




Flat Roofs

- Flat roofs require a continuous membrane roofing material.
- Minimum recommended slope: 1/4" per foot (1:50)
- The roof slope may be achieved by inclining the structural members or roof deck, or by tapering the layer of thermal insulation.
- The slope usually leads to interior drains. Secondary, emergency overflow roof drains or scuppers are required in cases where water might be trapped if the primary roof drains are blocked.

- Flat roofs can efficiently cover a building of any horizontal dimension, and may be structured and designed to serve as an outdoor space.
- The structure of a flat roof may consist of:
  - Reinforced concrete slabs
  - Flat timber or steel trusses
  - Timber or steel beams and decking
  - Wood or steel joists and sheathing

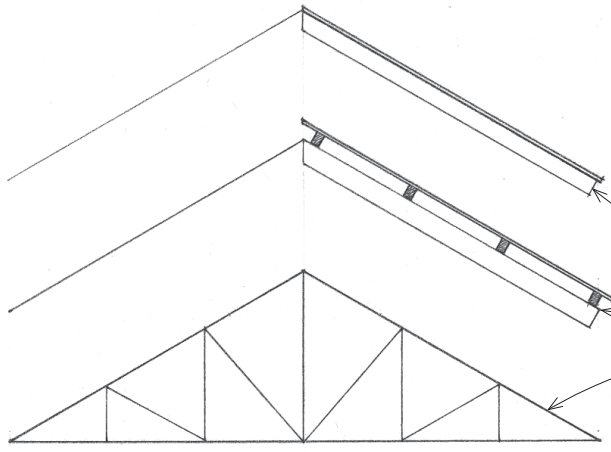


Sloping Roofs

- Sloping roofs may be categorized into
  - Low-slope roofs—up to 3:12
  - Medium- to high-slope roofs—4:12 to 12:12

- The roof slope affects the choice of roofing material, the requirements for underlayment and eave flashing, and design wind loads.
- Low-slope roofs require roll or continuous membrane roofing; some shingles and sheet materials may be used on 3:12 pitches.
- Medium- and high-slope roofs may be covered with shingles, tiles, or sheet materials.
- Sloping roofs shed rainwater easily to eave gutters.

- The height and area of a sloping roof increase with its horizontal dimensions.
- The space under a sloping roof may be usable.
- Sloping roof planes may be combined to form a variety of roof forms.

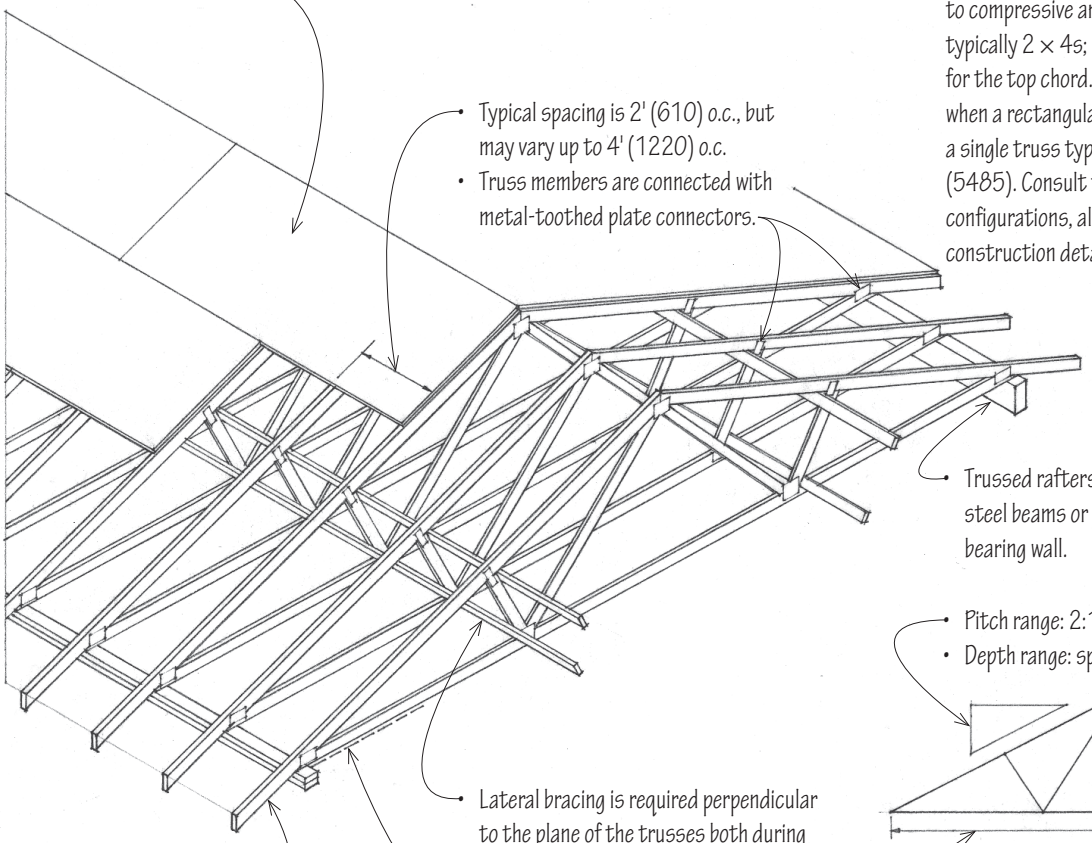


- Sloping roofs may have a structure of:
  - Wood or steel rafters and sheathing
  - Timber or steel beams, purlins, and decking
  - Timber or steel trusses

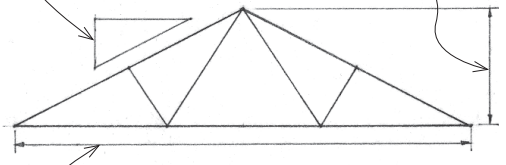
6.32 WOOD TRUSSED RAFTERS

Wood trussed rafters are pre-engineered and shop-fabricated monoplanar trusses. Because the individual members are subject primarily to compressive and tensile forces, they are typically 2 × 4s; 2 × 6s are sometimes used for the top chord. Trussed rafters are best used when a rectangular plan requires a quantity of a single truss type and clear spans over 18' (5485). Consult the truss manufacturer for configurations, allowable spans and loads, and construction details.

- Sheathing requirements are similar to those for conventional rafter framing; see 6.23.
- Typical spacing is 2' (610) o.c., but may vary up to 4' (1220) o.c.
- Truss members are connected with metal-toothed plate connectors.



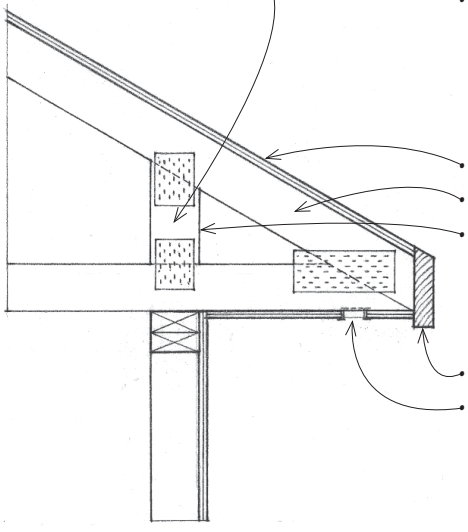
- Trussed rafters may be supported by timber or steel beams or by a stud-framed or masonry bearing wall.



- Pitch range: 2:12 to 8:12
- Depth range: span/10 to span/20
- Trussed rafters typically span from 20' to 32' (6095 to 9755); up to 60' (18 m) spans are possible.
- See 6.09 for a description of truss configurations.

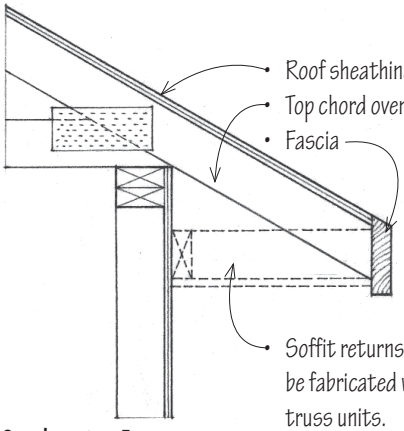
- 2' (610) maximum extension of top chord for overhangs
- Greater overhangs up to the 1/4 points are possible with the use of wedge blocks or struts.

- Lateral bracing is required perpendicular to the plane of the trusses both during installation and after erection.
- A ceiling may be applied directly to the bottom chords. For trusses spaced more than 2' (610) o.c., furring strips may be required to support the ceiling material.
- Thermal insulation as well as electrical and mechanical equipment may be accommodated within the truss depth.



- Roof sheathing
- Top chord
- Web block or strut tied to web system of truss
- Fascia
- Vented soffit

Soffited Eave



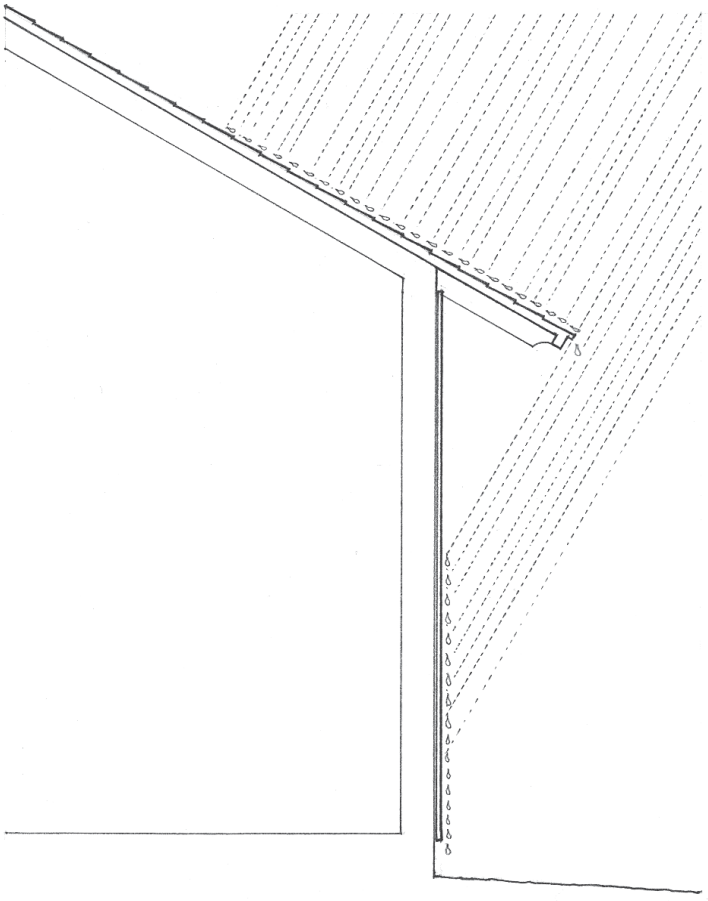
- Roof sheathing
- Top chord overhang
- Fascia
- Soffit returns may be fabricated w/ truss units.

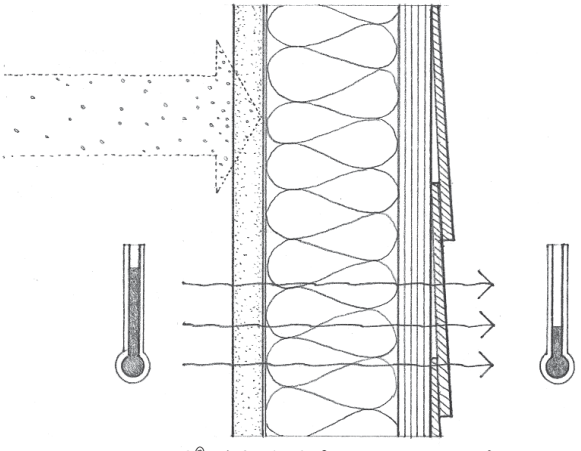
Overhanging Eave

7

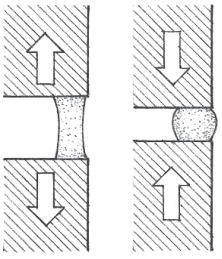
MOISTURE & THERMAL PROTECTION

7.02 Moisture & Thermal Protection
7.03 Underlayment for Shingle Roofing
7.04 Wood Shingles
7.05 Wood Shakes
7.06 Composition Shingles
7.07 Slate Shingles
7.08 Tile Roofing
7.09 Vegetated Roofing
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7.17 Roof Drainage
7.18 Flashing
7.19 Roof Flashing
7.21 Flashing Roof Penetrations
7.22 Wall Flashing
7.23 Rainscreen Wall Systems
7.24 Curtain Walls
7.27 Precast Concrete Panels
7.28 Masonry Veneer
7.30 Stone Veneer
7.31 Metal Cladding
7.32 Plywood Siding
7.33 Wood Shingle Siding
7.34 Horizontal Board Siding
7.35 Vertical Board Siding
7.36 Stucco
7.37 Stucco Details
7.38 Exterior Insulation & Finish Systems
7.39 Thermal Insulation
7.40 Thermal Resistance of Building Materials
7.41 Insulating Materials
7.43 Insulating Roofs & Floors
7.44 Insulating Walls
7.45 Moisture Control
7.46 Vapor Retarders
7.48 Air Barriers
7.49 Ventilation
7.50 Movement Joints
7.52 Joint Sealants





LEED® EA Credit 2: Optimize Energy Performance



Roofing materials provide the water-resistant covering for a roof system. They range in form from virtually continuous, impervious membranes to overlapping or interlocking pieces of shingles and tiles. The type of roofing that may be used depends on the pitch of the roof structure. While a sloping roof easily sheds water, a flat roof must depend on a continuous waterproof membrane to contain the water while it drains or evaporates. A flat roof as well as any well-insulated sloping roof capable of retaining snow may therefore have to be designed to support a greater live load than a moderately or high-pitched roof. Additional factors to consider in the selection of a roofing material include requirements for installation, maintenance, and durability, resistance to wind and fire, and, if visible, the roofing pattern, texture, and color.

To prevent water from leaking into a roof assembly and eventually the interior of a building, flashing must be installed along roof edges, where roofs change slope or abut vertical planes, and where roofs are penetrated by chimneys, vent pipes, and skylights. Exterior walls must also be flashed where leakage might occur—at door and window openings and along joints where materials meet in the plane of the wall.

Exterior walls also must provide protection from the weather. While some exterior wall systems, such as solid masonry and concrete loadbearing walls, use their mass as barriers against the penetration of water into the interior of a building, other wall systems, such as cavity walls and curtain walls, use an interior drainage system to carry away any moisture that finds its way through the facing or cladding.

Moisture is normally present in the interior spaces of a building in the form of water vapor. When this water vapor reaches a surface cooled by heat loss to the colder outside air, condensation may occur. This condensation may be visible, as on an uninsulated window pane, or it can collect in concealed roof, wall, or floor spaces. Means of combating condensation include the correct placement of thermal insulation and vapor retarders, and the ventilation of concealed spaces, such as attics and crawl spaces.

Potential heat loss or gain through the exterior enclosure of a building is an important factor when estimating the amount of mechanical equipment and energy required to maintain the desired level of environmental comfort in the interior spaces. The proper selection of building materials, the correct construction and insulation of the building enclosure, and the orientation of a building on its site are the basic means of controlling heat loss and gain.

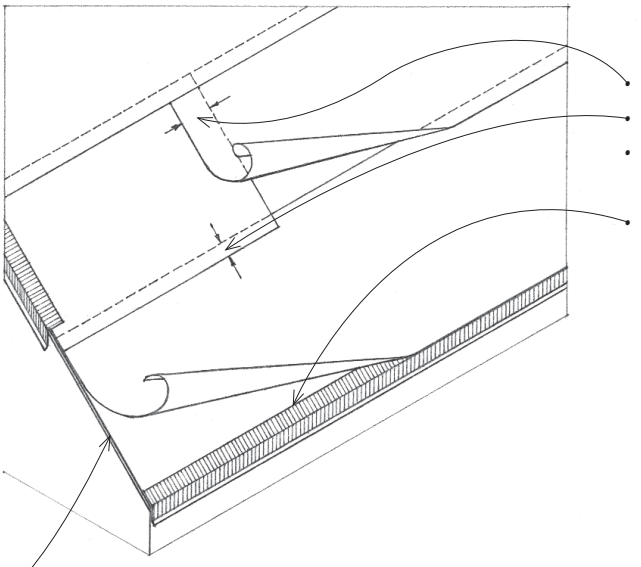
Building materials expand and contract due to variations within the normal temperature range, as well as exposure to solar radiation and wind. To allow for this movement and help relieve the stresses caused by thermal expansion and contraction, expansion joints should be flexible, weathertight, durable, and correctly placed to be effective.

Underlayment protects the roof sheathing from moisture until the roofing shingles are applied. Once the roofing is applied, the underlayment provides the sheathing with additional protection from wind-driven rain. The underlayment material should have low vapor resistance so that moisture does not accumulate between the underlayment and the roof sheathing. Only enough nails are used to hold the underlayment in place until the roofing shingles are applied.

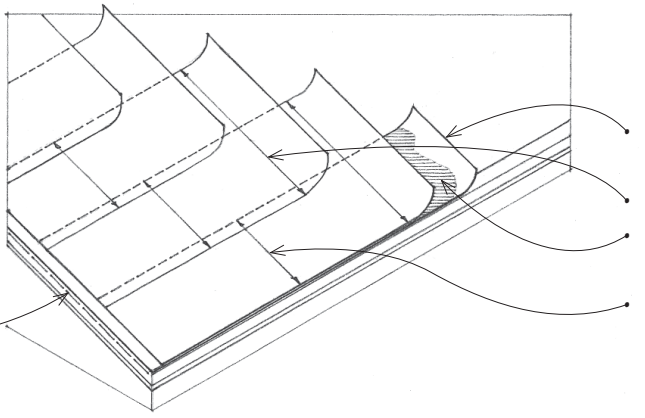
Eave Flashing

Eave flashing is required whenever there is a possibility that ice might form along the eave and cause melting ice and snow to back up under the roofing shingles.

- On normal slope roofs, eave flashing consists of two layers of 15 lb. felt or a single layer of 50 lb. smooth roll roofing extending from the eave up the roof to a point 24" (610) inside the interior wall line.
- On low slope roofs, an additional course of underlayment is cemented in place, and extended to a point 36" (915) inside the interior wall line.



Underlayment for Normal Slopes (4:12 and up)

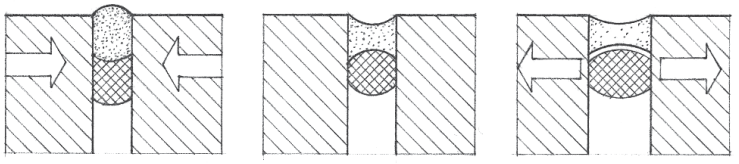


Underlayment for Low Slope Roofs (3:12 to 4:12)

Underlayment and Sheathing for Shingle Roofs

Roofing Type	Sheathing	Underlayment	Normal Slope		Low Slope	
Fiberglass shingles	Solid	15 lb. asphalt-saturated felt	4:12 and up	Single layer	3:12 to 4:12	Double layer
Asphalt shingles	Solid	15 lb. asphalt-saturated felt	4:12 and up	Single layer	2:12 to 4:12	Double layer
Wood shingles	Spaced	15 lb. asphalt-saturated felt	4:12 and up	Optional	3:12 to 4:12	Reduce weather exposure
	Solid	15 lb. asphalt-saturated felt	4:12 and up	Optional; eave flashing required in snow areas	3:12 to 4:12	Optional; eave flashing required in snow areas
Wood shakes	Spaced	30 lb. asphalt-saturated felt (interlayment)	4:12 and up		Not recommended	
	Solid	30 lb. asphalt-saturated felt (interlayment)	4:12 and up		3:12 to 4:12	Single layer underlayment and interlayment over entire roof

To provide an effective seal against the passage of water and air, a joint sealant must be durable, resilient, and have both cohesive and adhesive strength. Sealants can be classified according to the amount of extension and compression they can withstand before failure.



• Compressed • As installed •Elongated

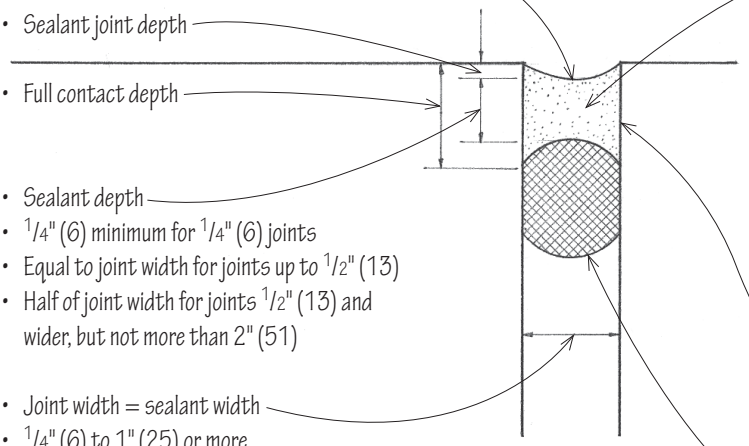
Joint Movement

Low-Range Sealants
- Movement capability of +/– 5%
- Oil-based or acrylic compounds
- Often referred to as caulking and used for small joints where little movement is expected

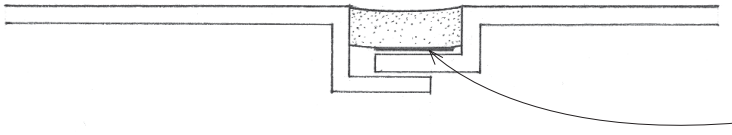
Medium-Range Sealants
- Movement capability of +/– 5% to +/– 10%
- Butyl rubber, acrylic, or neoprene compounds
- Used for nonworking, mechanically fastened joints

High-Range Sealants
- Movement capability of +/– 12% to +/– 25%
- Polymercaptans, polysulfides, polyurethanes, and silicones
- Used for working joints subject to a significant amount of movement, such as those in curtain walls

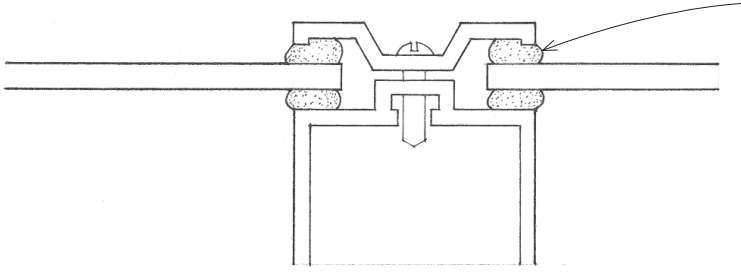
- Joints should be tooled to ensure full contact with and adhesion to substrate
- Sealant joint depth
- Full contact depth
- Sealant depth
- 1/4" (6) minimum for 1/4" (6) joints
- Equal to joint width for joints up to 1/2" (13)
- Half of joint width for joints 1/2" (13) and wider, but not more than 2" (51)
- Joint width = sealant width
- 1/4" (6) to 1" (25) or more
- Width depends on the joint spacing, expected temperature range, anticipated movement due to wind or structural displacement, and the movement capability of the sealant.



- The substrate must be clean, dry, and compatible with the sealant material.
- A primer may be required to improve the adhesion of a sealant to the substrate.
- The joint filler controls the depth of the sealant contact with the joining parts. It should be compressible and be compatible with but not adhere to the sealant. It may be in the form of a rod or tubing of polyethylene foam, polyurethane foam, neoprene, or butyl rubber.



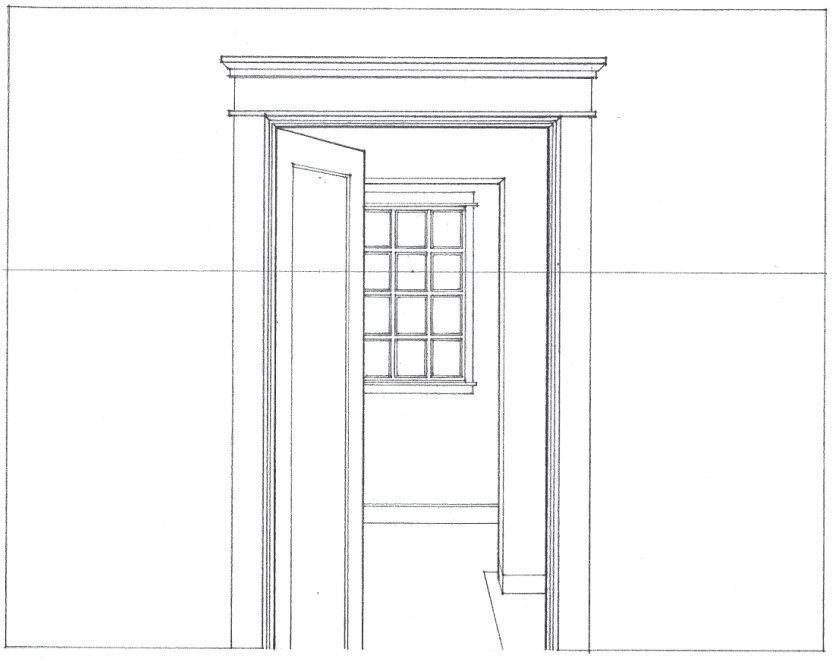
- When there is insufficient depth for a compressible filler, a bond breaker, such as polyethylene tape, is required to prevent adhesion between the sealant and the bottom of the joint recess.

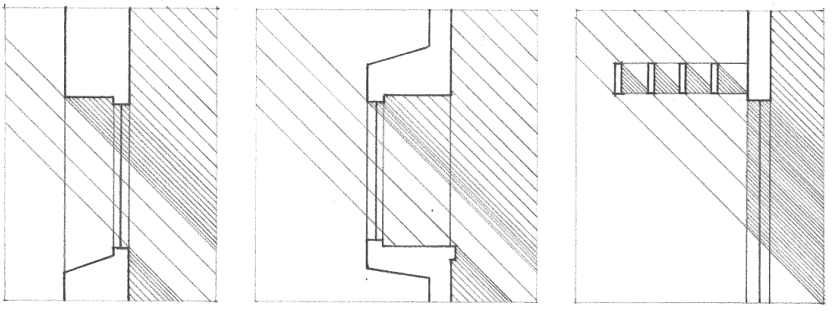


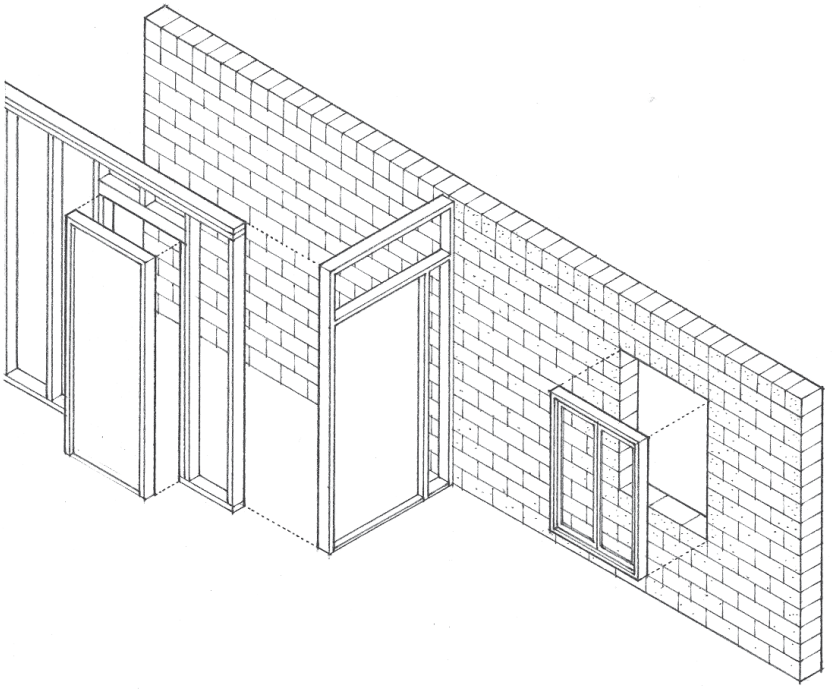
- Most sealants are viscous liquids that cure after being applied with a hand-operated or power gun. These are referred to as gunnable sealants. Some lap joints, however, are difficult to seal with gunnable sealants. These joints may require instead a preformed solid polybutene or polyisobutylene tape sealant that is held in place under compression.

8
DOORS & WINDOWS

8.02 Doors & Windows
8.03 Doors & Doorways
8.04 Door Operation
8.05 Hollow Metal Doors
8.06 Hollow Metal Doorframes
8.08 Wood Flush Doors
8.09 Wood Rail & Stile Doors
8.10 Wood Doorframes
8.11 Sliding Glass Doors
8.12 Folding & Pocket Sliding Doors
8.13 Overhead & Coiling Doors
8.14 Glass Entrance Doors
8.15 Storefronts
8.16 Revolving Doors
8.17 Door Hardware
8.18 Door Hinges
8.19 Door Locksets
8.20 Panic Hardware & Closers
8.21 Weatherstripping & Thresholds
8.22 Window Elements
8.23 Window Operation
8.24 Metal Windows
8.26 Wood Windows
8.28 Glazing Systems
8.30 Insulating Glass
8.31 Safety Glazing
8.33 Glazed Curtain Walls
8.39 Double-Skin Facades
8.40 Smart Facades
8.42 Skylights
8.43 Skylight Details
8.44 Sunspaces







Doors and doorways provide access from the outside into the interior of a building as well as passage between interior spaces. Doorways should therefore be large enough to move through easily and accommodate the moving of furnishings and equipment. They should be located so that the patterns of movement they create between and within spaces are appropriate to the uses and activities housed by the spaces.

Exterior doors should provide weathertight seals when closed and maintain the approximate thermal insulation value of the exterior walls they penetrate. Interior doors should offer the desired degree of visual and acoustical privacy. All doors should be evaluated for their ease of operation, durability under the anticipated frequency of use, security provisions, and the light, ventilation, and view they may offer. Further, there may be building code requirements for fire resistance, emergency egress, and safety glazing that must be satisfied.

There are many types and sizes of windows, the choice of which affects not only the physical appearance of a building, but also the natural lighting, ventilation, view potential, and spatial quality of the building's interior spaces. As with exterior doors, windows should provide a weathertight seal when closed. Window frames should have low thermal conductivity or be constructed to interrupt the flow of heat. Window glazing should retard the transmission of heat and control solar radiation and glare.

Because door and window units are normally factory built, their manufacturers may have standard sizes and corresponding rough-opening requirements for the various door and window types. The size and location of doors and windows should be carefully planned so that adequate rough openings with properly sized lintels can be built into the wall systems that will receive them.

From an exterior point of view, doors and windows are important compositional elements in the design of building facades. The manner in which they punctuate or divide exterior wall surfaces affects the massing, visual weight, scale, and articulation of the building form.

Door Types

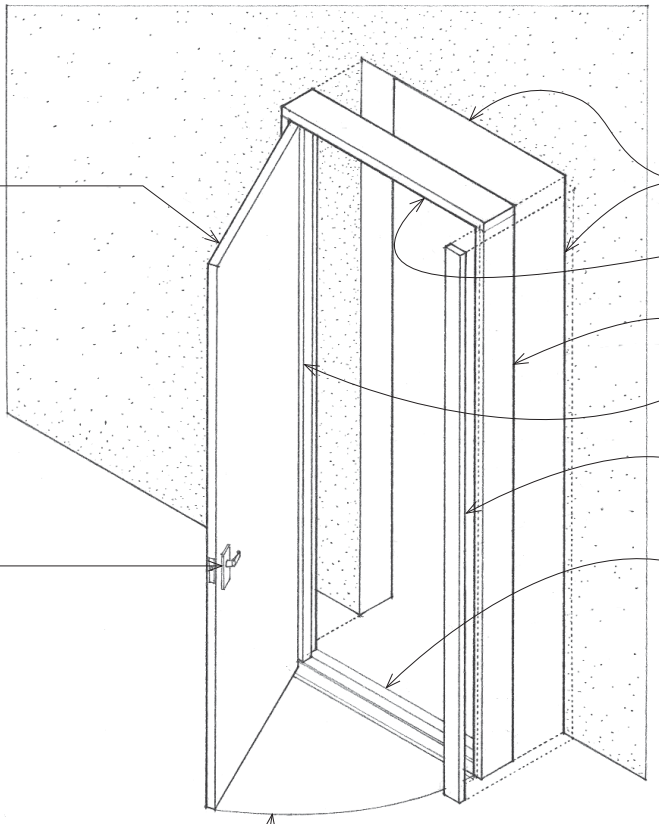
- Hollow metal doors and frames; see 8.05–8.07.
- Wood doors and frames; see 8.08–8.10.

Door Hardware

- Door hardware includes the metal fastenings and fittings required for the operation of a door, such as hinges, locksets, and closers; see 8.17–8.21.

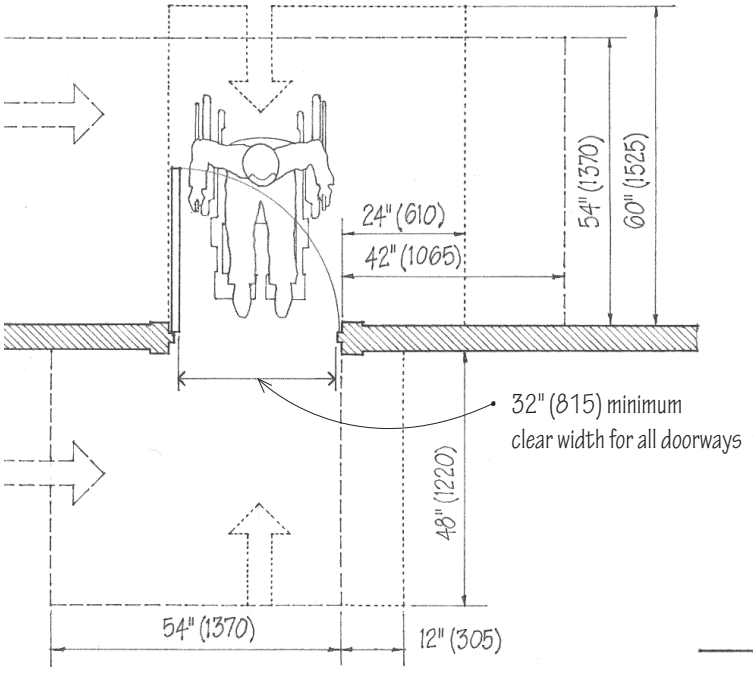
Door Operation

- See 8.04.

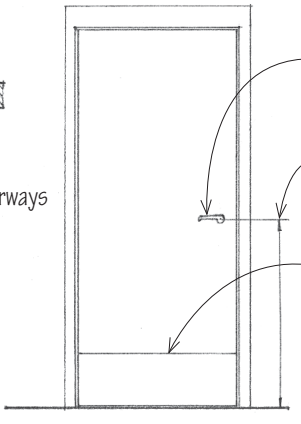


- The detailing of a doorframe establishes the appearance of a doorway. Depending on the thickness of the wall construction, a doorframe may be set within the rough opening or overlap its edges.
- Rough opening is the wall opening into which a doorframe is fitted.
- Head is the uppermost member of a doorframe.
- Jamb refers to either of the two side members of a doorframe.
- Stop is the projecting part of a doorframe against which a door closes.
- Casing is the trim that finishes the joint between a doorframe and its rough opening.
- Threshold is the sill of a doorway, covering the joint between two flooring materials or providing weather protection at an exterior door.
- ADA accessibility guidelines require that a threshold, if provided, be no higher than 1/2" (13) and beveled with a slope not steeper than 1:2.
- Saddle is a raised piece of flooring between the jambs of a doorway, to which a door fits closely so as to prevent its binding when opened.

Doorframes

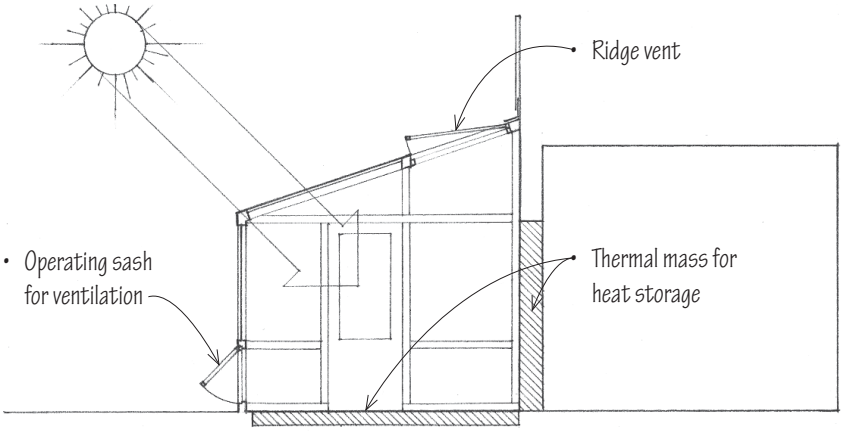


Minimum Maneuvering Clearances at Doorways

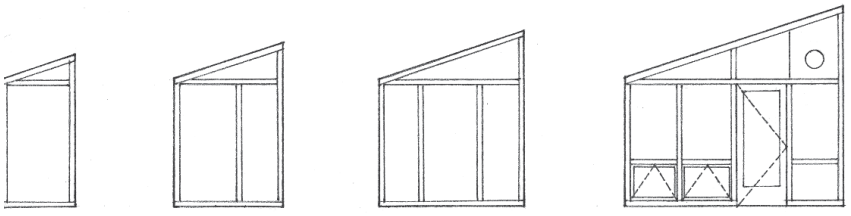


- Operating hardware should be easy to grasp with one hand without tight pinching or twisting of the wrist.
- 48" (1220) maximum height above floor for hardware required for accessible door passage.
- The bottom 12" (305) of doors should have a smooth uninterrupted surface to allow the door to be opened by a wheelchair footrest.

ADA Accessibility Guidelines for Doors

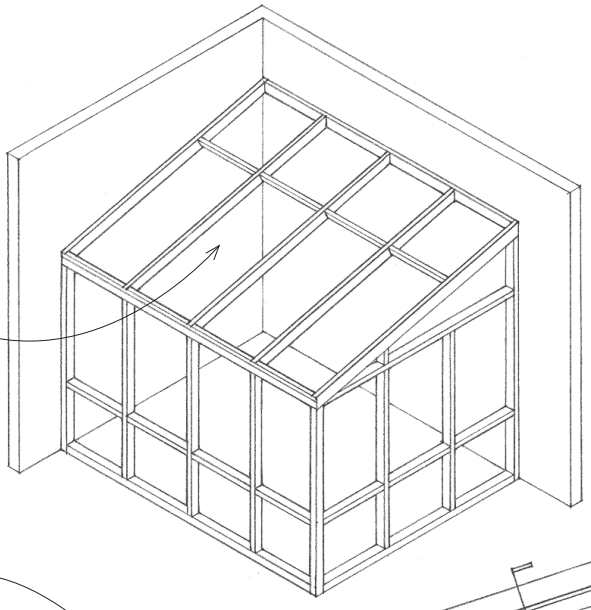


A sunspace is a glass-enclosed porch or room adjoining another living space and oriented to admit large amounts of sunlight. Sunspaces are often used in passive solar design in conjunction with a thermal mass of masonry, rock, or concrete to store the solar heat gain. Because of the possibility of overheating, provision should be made for shading and ventilation with operable windows and, if necessary, an exhaust fan.



- Sunspaces, solariums, and greenhouses are available as manufactured systems with wood or metal frames, complete with glazing and flashing.
- A ventilating fan can be mounted on the roof or in either of the gable ends.
- Insulating shades and blinds follow the slope of the roof and can be operated manually or by remote control.
- French or sliding doors can be located in either of the gable ends.
- Awning and casement sashes for ventilation are available for the front and side walls; some systems offer ventilating roof sashes.

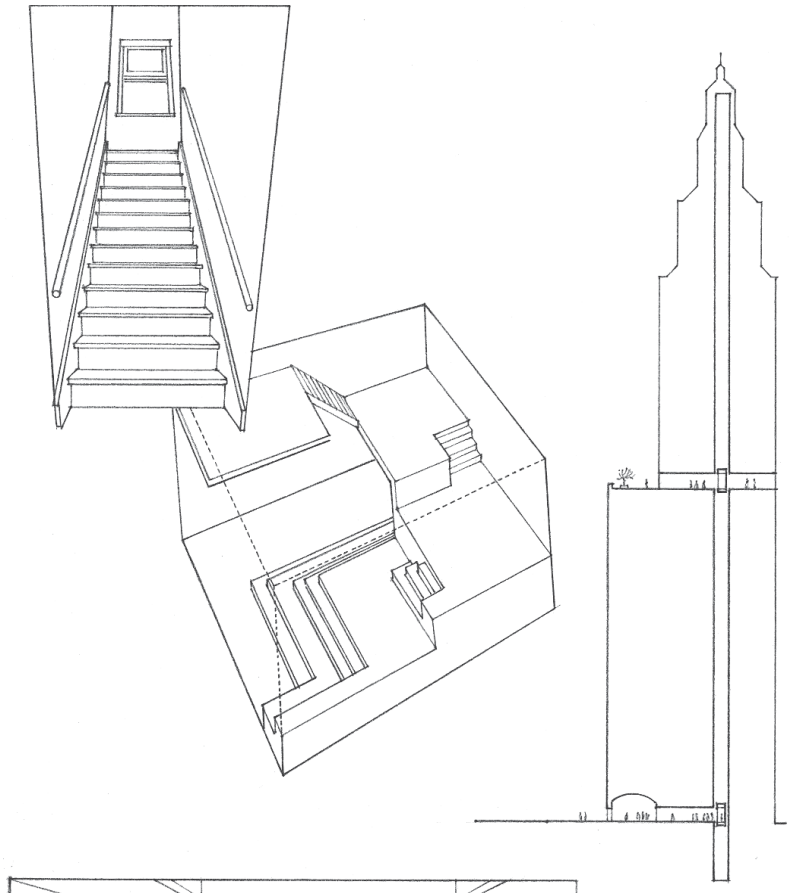
- Safety screening is not required for the sloped glazing of commercial or detached greenhouses provided the structures are not intended for public use and the ridge height above grade does not exceed 20' (6095).

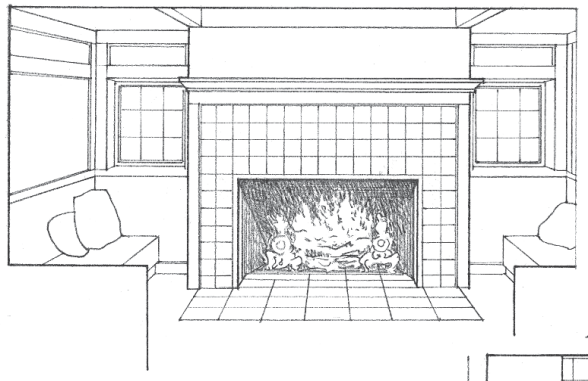


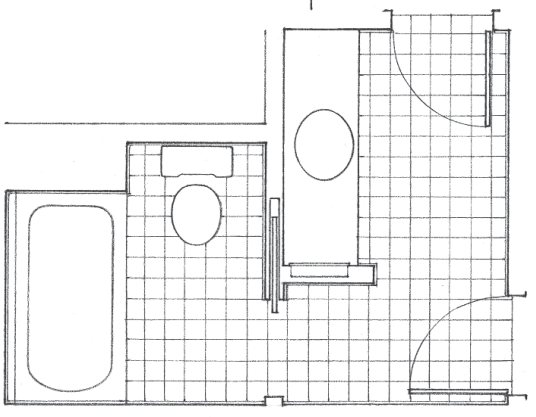
- The details in the lower half of 8.37 characterize the construction of metal-framed glazed structures. Shown below are typical details for a wood-framed sunspace or solarium.

9
SPECIAL CONSTRUCTION

9.02 Special Construction
9.03 Stair Design
9.04 Stair Requirements
9.06 Stair Plans
9.08 Wood Stairs
9.10 Concrete Stairs
9.11 Steel Stairs
9.12 Spiral Stairs
9.13 Ladders
9.14 Elevators
9.17 Escalators
9.18 Fireplaces
9.19 Fireplace Requirements
9.20 Masonry Chimneys
9.21 Prefabricated Fireplaces & Stoves
9.22 Kitchen Layouts
9.23 Kitchen Dimensions
9.24 Kitchen Cabinets
9.25 The Kitchen Space
9.26 Bathroom Layouts
9.27 Plumbing Fixtures
9.28 Accessible Fixtures
9.30 The Bathroom Space







This chapter discusses those elements of a building that have unique characteristics and that therefore should be considered as separate entities. While not always affecting the exterior form of a building, they do influence the internal organization of spaces, the pattern of the structural system, and in some cases, the layout of heating, plumbing, and electrical systems.

Stairs provide means for moving from one level to another and are therefore important links in the overall circulation scheme of a building. Whether punctuating a two-story volume or rising through a narrow shaft, a stairway takes up a significant amount of space. The landings of a stairway should be logically integrated with the structural system to avoid overly complicated framing conditions. Safety and ease of travel are, in the end, the most important considerations in the design and placement of stairs.

Multistory buildings require elevators to move people, equipment, and freight from one floor to another. For accessibility to multistory public and commercial facilities by persons with disabilities, federal regulations mandate their installation. An alternative to elevators is the escalator, which can move a large number of people efficiently and comfortably between a limited number of floors.

Fireplaces and woodburning stoves are sources of heat and visual points of interest for any interior space. The placement and size of a fireplace or stove in a room should be related to the scale and use of the space. Both fireplaces and stoves must be located and constructed to draft properly. The damper and flue sizes should correspond to the size and proportions of the firebox and precautions should be taken against fire hazards and heat loss.

Kitchens and bathrooms are unique areas of a building that demand the careful integration of plumbing, electrical, and heating/ventilating systems with the functional and aesthetic requirements of the spaces. These areas also require special fixtures and equipment, as well as durability, ease of maintenance, and sanitary surfaces and finishes.

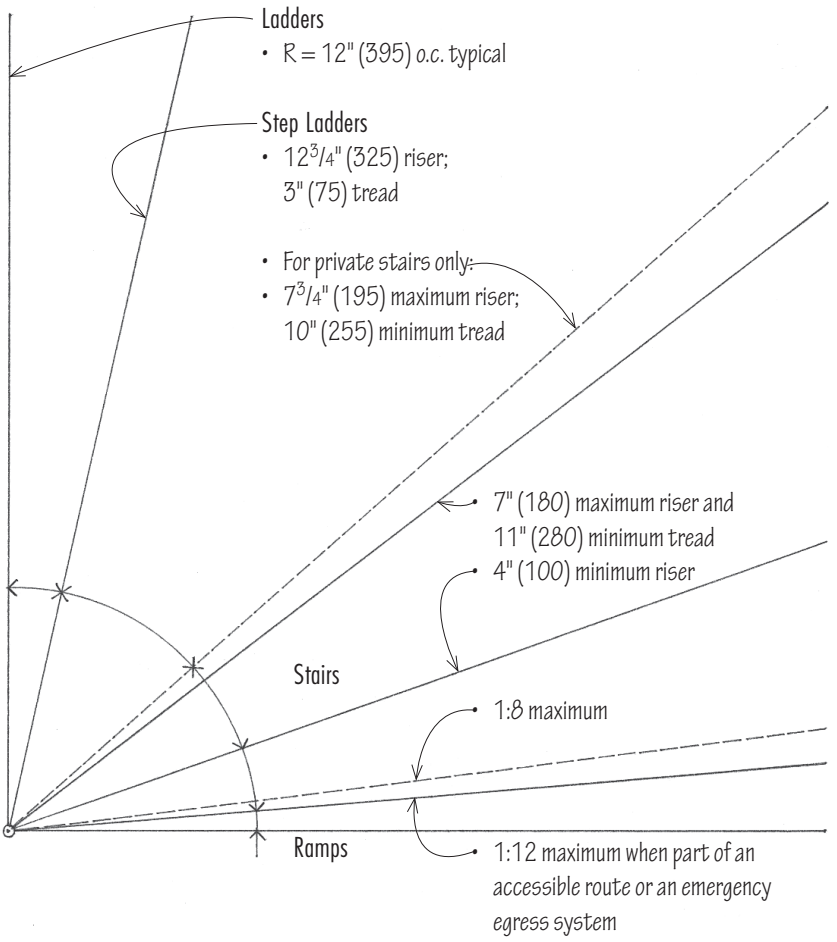
The dimensions of risers and treads in a stairway should be proportioned to accommodate our body movement. Their pitch, if steep, can make ascent physically tiring as well as psychologically forbidding, and can make descent precarious. If the pitch of a stairway is shallow, its treads should be deep enough to fit our stride.

Building codes regulate the minimum and maximum dimensions of risers and treads; see 9.04–9.05. For comfort, the riser and tread dimensions can be proportioned according to either of the following formulas:

- Tread (inches) + 2× riser (inches) = 24 to 25
- Riser (inches) × tread (inches) = 72 to 75

Exterior stairs are generally not as steep as interior stairs, especially where dangerous conditions such as snow and ice exist. The proportioning formula can therefore be adjusted to yield a sum of 26.

For safety, all risers in a flight of stairs should be the same rise and all treads should have the same run. Building codes limit the allowable variation in riser height or tread run to $^3/_8$" (9.5 mm). Consult the building code to verify the dimensional guidelines outlined on this and the following page.



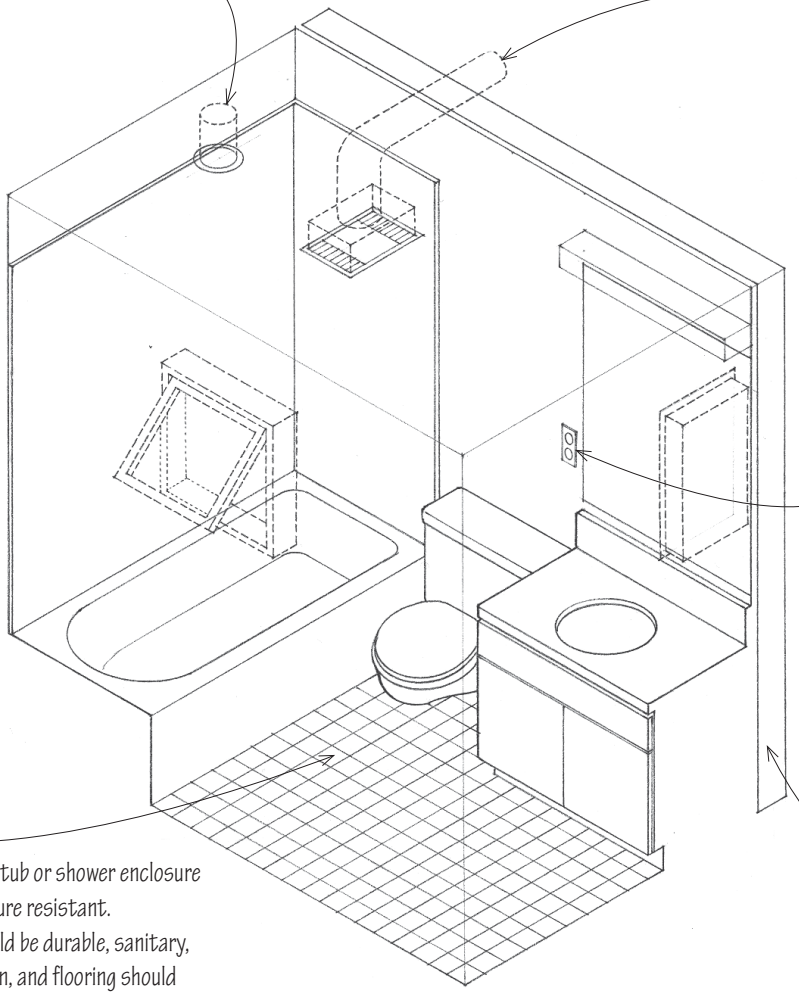
- The actual riser and tread dimensions for a set of stairs are determined by dividing the total rise or floor-to-floor height by the desired riser height. The result is rounded off to arrive at a whole number of risers. The total rise is then redivided by this whole number to arrive at the actual riser height.
- This riser height must be checked against the maximum riser height allowed by the building code. If necessary, the number of risers can be increased by one and the actual riser height recalculated.
- Once the actual riser height is fixed, the tread run can be determined by using the riser:tread proportioning formula.
- Since in any flight of stairs, there is always one less tread than the number of risers, the total number of treads and the total run can be easily determined.

Riser and Tread Dimensions

Riser inches (mm)	Tread inches (mm)	
5 (125)	15 (380)	
5 1/4 (135)	14 1/2 (370)	
5 1/2 (140)	14 (355)	
5 3/4 (145)	13 1/2 (340)	
6 (150)	13 (330)	
6 1/4 (160)	12 1/2 (320)	
6 1/2 (165)	12 (305)	
6 3/4 (170)	11 1/2 (290)	
7 (180)	11 (280)	• Maximum riser height; minimum tread depth for accessible stairs and emergency egress
7 1/4 (185)	10 1/2 (265)	
7 1/2 (190)	10 (255)	

Lighting

- Natural lighting by means of exterior glazed openings is always desirable.
- A single overhead light fixture is usually not acceptable; auxiliary lighting is required over the tub or shower, over the lavatory and vanity counter, and over any compartmentalized toilet spaces.
- The light fixture over the tub or shower should be resistant to water vapor.



Ventilation

- Bathrooms require either natural or mechanical ventilation in order to remove stale air and supply fresh air.
- Provide natural ventilation by means of openable exterior openings with an area not less than 1/20 of the floor area or a minimum of 1 1/2 s.f. (0.14 m^2).
- A mechanical ventilating system may be employed in lieu of natural ventilation.
- The ventilating fan should be located close to the shower and high on an exterior wall opposite the bathroom door. It should be connected directly to the outside and be capable of providing five air changes per hour. The point of discharge should be at least 3' (915) away from any opening that allows outside air to enter the building.
- Residential exhaust fans are often combined with a light fixture, a fan-forced heater, or a radiant heat lamp.

Electrical

- Electrical switches and convenience outlets should be located where they are needed but away from water or wet areas. They should not be accessible from a bathtub or shower.
- All convenience outlets should be protected by a ground fault interrupter (GFI); see 11.33.

Plumbing

- Plumbing walls should have sufficient depth to accommodate the required water supply and waste lines and vents.
- See 11.24–11.28.

Finishes

- Backing for bathtub or shower enclosure should be moisture resistant.
- All finishes should be durable, sanitary, and easy to clean, and flooring should have a nonslip surface.

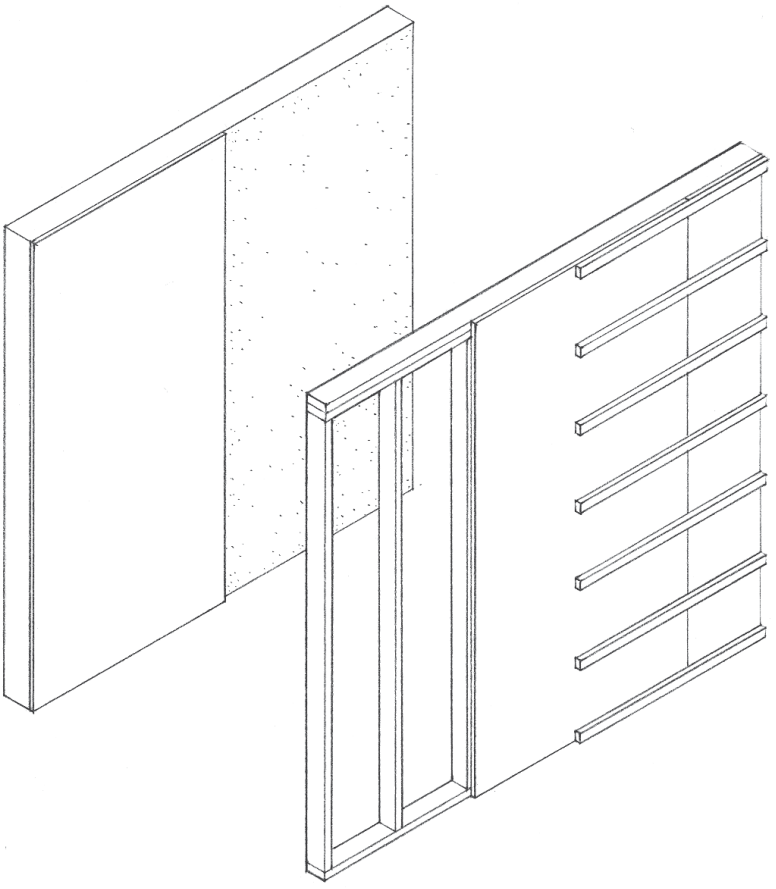
Heating

- Heating may be supplied in the conventional manner through warm-air registers in the floor, hydronic or electric baseboard units, or electric resistance heaters in the wall.

- Space is required for accessories such as a medicine cabinet, mirror, towel bars, toilet paper holder, and soap dish.
- Storage space is required for towels, linen, and cleaning supplies.

10
FINISH WORK

10.02 Finish Work
10.03 Plaster
10.04 Plaster Lath & Accessories
10.05 Plaster Partition Systems
10.06 Plaster Details
10.07 Plaster over Masonry
10.08 Plaster Ceilings
10.09 Gypsum Board
10.10 Gypsum Board Application
10.11 Gypsum Board Details
10.12 Ceramic Tile
10.13 Ceramic Tile Application
10.14 Ceramic Tile Details
10.15 Terrazzo Flooring
10.16 Wood Flooring
10.17 Wood Flooring Installation
10.18 Stone Flooring
10.19 Resilient Flooring
10.20 Carpeting
10.22 Acoustical Ceiling Tiles
10.23 Suspended Acoustical Ceilings
10.24 Wood Joints
10.26 Wood Moldings & Trim
10.28 Wood Paneling
10.29 Plywood Veneer
10.30 Plastic Laminate

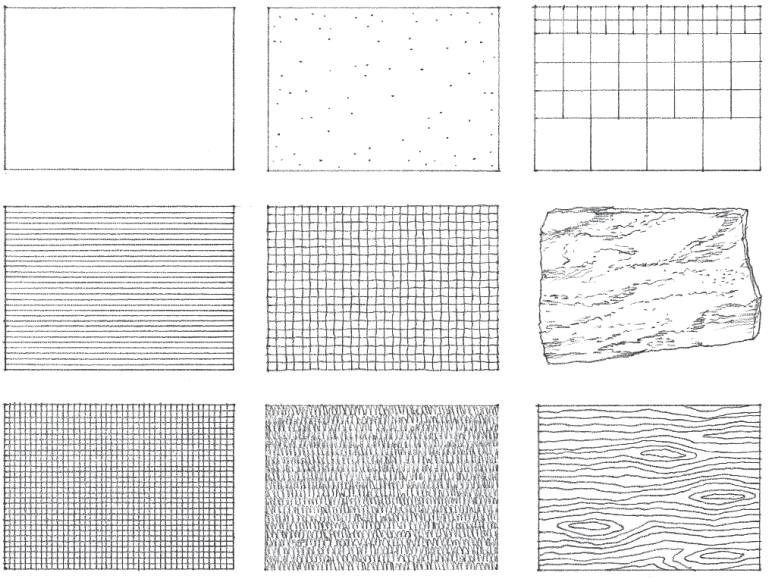


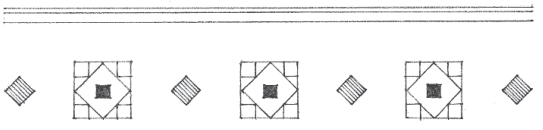
This chapter illustrates the major materials and methods used to finish the interior wall, ceiling, and floor surfaces of a building. Interior walls should be resistant to wear and be cleanable; floors should be durable, comfortable, and safe to walk on; ceilings should be relatively maintenance-free.

Because exterior wall surfaces, such as stucco and wood siding, must serve effectively as barriers against the penetration of water into the interior of a building, they are covered in Chapter 7 along with roof coverings.

Rigid finish materials capable of spanning short distances may be applied to a supporting grid of linear members. More flexible finish materials, on the other hand, require a solid, rigid backing. Additional technical factors to consider include the acoustic qualities, fire resistance, and thermal insulation value of a finish material.

Surface finishes have a critical influence on the aesthetic qualities of a space. In the selection and use of a finish material, we should carefully consider its color, texture, and pattern, and the way it meets and joins with other materials. If a finish material has modular characteristics, then its unit dimensions can be used to regulate the dimensions of a wall, floor, or ceiling surface.







LEED EQ Credit 2: Low-Emitting Materials

Plaster refers to any of various mixtures applied in a pasty form to the surfaces of walls or ceilings in a plastic state and allowed to harden and dry. The most common type of plaster used in construction is gypsum plaster, which is made by mixing calcined gypsum with water, fine sand or lightweight aggregate, and various additives to control its setting and working qualities. Gypsum plaster is a durable, relatively lightweight, and fire-resistant material that can be used on any wall or ceiling surface that is not subject to moist or wet conditions. Portland cement plaster, also known as stucco, is used on exterior walls and in areas subject to wet or moist conditions; see 7.36.

- Plaster is applied in layers, the number of which depends on the type and strength of base used.

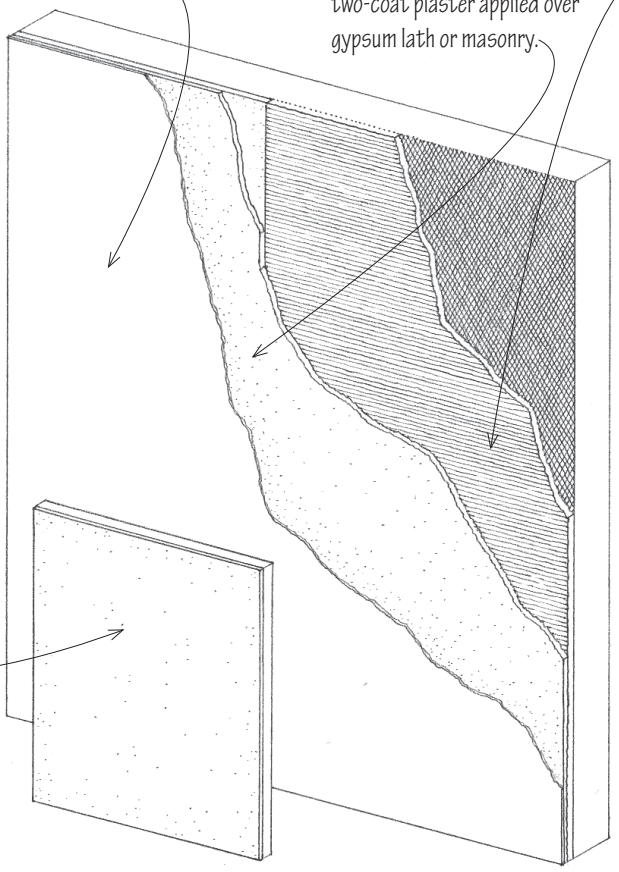
Two-Coat Plaster

- Plaster is applied in two coats, a basecoat followed by a finish coat.

Three-Coat Plaster

- Plaster is applied in three successive coats, a scratch coat followed by a brown coat and a finish coat.

- Finish coat is the final coat of plaster, serving either as a finished surface or as a base for decoration.
- Brown coat is a roughly finished, leveling coat of plaster, either the second coat in three-coat plaster or the base coat in two-coat plaster applied over gypsum lath or masonry.
- Basecoat refers to any plaster coat applied before the finish coat.
- Scratch coat is the first coat in three-coat plaster, which must adhere firmly to the lath and be raked to provide a better bond for the second or brown coat.



- Hard finish refers to a finish coat of lime putty and Keene's cement or gauging plaster, troweled to a smooth, dense finish.
- Keene's cement is a trademark for a brand of white anhydrous gypsum plaster that produces an exceptionally strong, dense, crack-resistant finish.
- Gauging plaster is a specially ground gypsum plaster for mixing with lime putty, formulated to control the setting time and counteract shrinkage in a finish coat of plaster.
- White coat refers to a finish coat of lime putty and white gauging plaster, troweled to a smooth, dense finish.

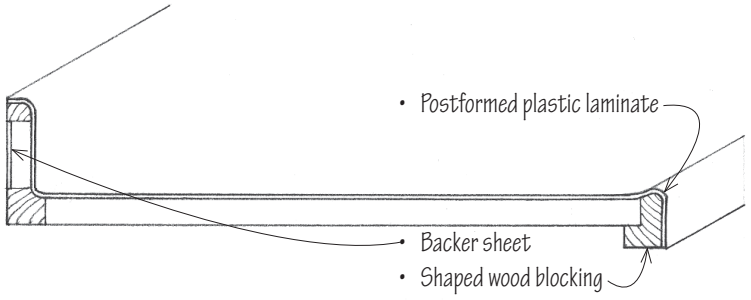
- Veneer or thin-coat plaster is a ready-mixed gypsum plaster applied as a very thin, one- or two-coat finish over a veneer base.

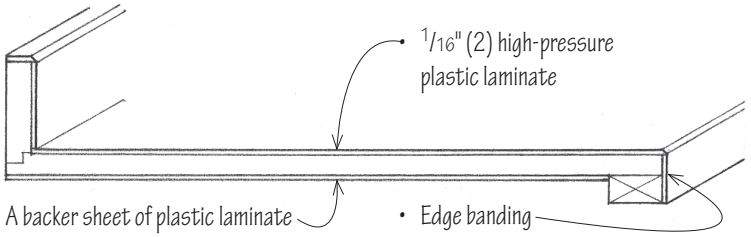
- Acoustical plaster is a low-density plaster containing vermiculite or other porous material to enhance its ability to absorb sound.
- Molding plaster, consisting of very finely ground gypsum and hydrated lime, is used for ornamental plasterwork.

- Wood-fibered plaster is mill-mixed gypsum basecoat plaster containing coarse cellulose fibers for greater bulk, strength, and fire resistance, used neat or mixed with sand to obtain a basecoat of superior hardness.
- Neat plaster is a gypsum basecoat plaster having no admixture except hair or other fiber, used for on-the-job mixing with aggregates.
- Ready-mixed plaster is a mill-prepared plaster mix of calcined gypsum and an aggregate, such as perlite or vermiculite. It requires only the addition of water.
- The addition of perlite or vermiculite reduces the weight and increases the thermal and fire resistance of the plaster.

- The final appearance of a plaster surface depends on both its texture and its finish. It may be troweled to produce a smooth, nonporous finish, floated to a sandy, lightly textured finish, or sprayed on for a rougher finish. The finish may be painted; smooth finishes will accept textile or paper wall coverings.

CSI MasterFormat™ 09 21 00: Plaster and Gypsum Board Assemblies
CSI MasterFormat 09 23 00: Gypsum Plastering





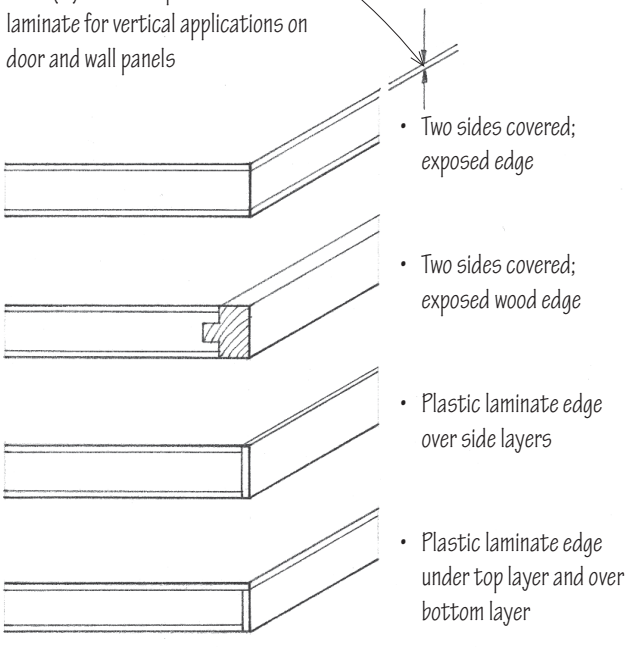
- A backer sheet of plastic laminate should be applied to the opposite side of unsupported panels to keep them from warping.

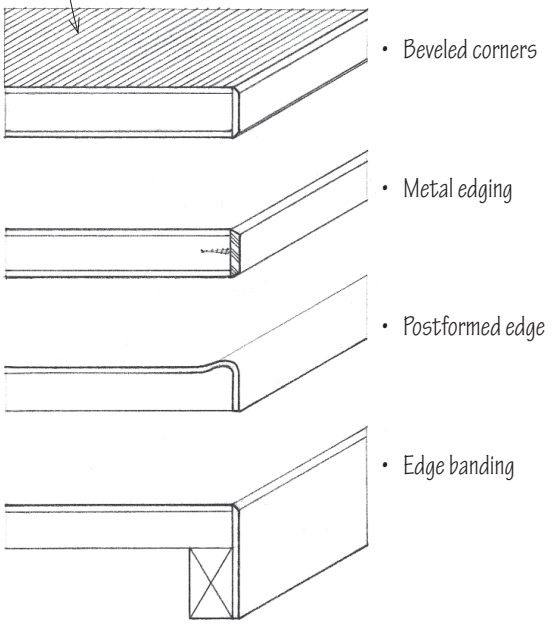
Plastic laminate is a hard surfacing material consisting of superposed layers of kraft paper, foil, printed paper, wood veneer, or fabric impregnated with melamine and phenolic resins, fused together under heat and pressure. Plastic laminates provide a durable, heat- and water-resistant surface covering for countertops, furniture, doors, and wall panels. They may be applied to smooth plywood, hardboard, particleboard, and other common core materials. They may be bonded with contact adhesive in the field or with thermosetting adhesive, under pressure, in the shop.

- High-pressure laminate is molded and cured in the range of pressures from 1200 to 2000 psi (84 to 140 kg/m^2), and used for surfacing countertops and tabletops.
- Low-pressure laminate is molded and cured with a maximum pressure of 400 psi (28 kg/m^2), and used in vertical and low-wear applications.
- Formica is a trademark for a brand of plastic laminate.
- Plastic laminate surfaces with tight rolls and bends should be postformed during manufacture and bonded with thermosetting adhesive. Postformed plastic laminate 1/20" (1.2 mm) thick may be bent to a radius as small as 3/4" (19). Plastic laminate edge banding may be bent to a radius of 3" (75) or smaller if heated.
- A wide range of colors and patterns is available in glossy, satin, low-glare, or textured finishes.

Plastic Laminate Countertops

- 1/16" (2) thick high-pressure laminate for horizontal applications on countertops and tabletops
- 1/32" (1) thick low-pressure laminate for vertical applications on door and wall panels





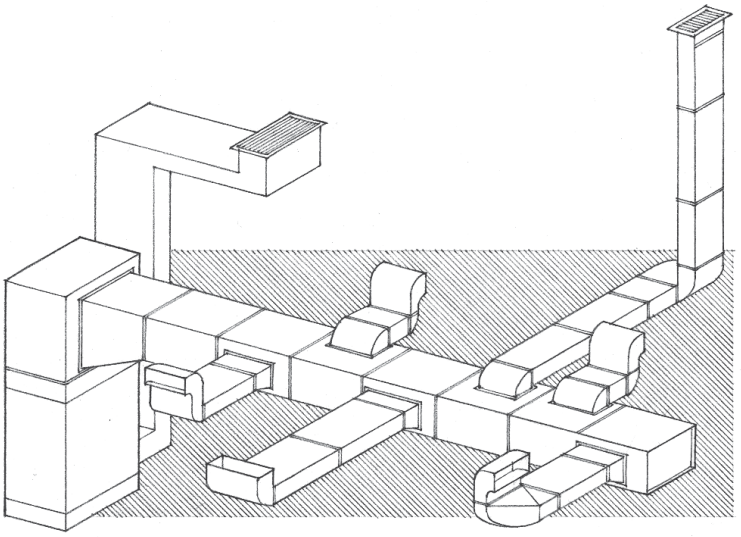
Edge Treatments for Plastic-Laminate-Faced Panels

CSI MasterFormat 06 41 16: Plastic-Laminate-Clad Architectural Cabinets
CSI MasterFormat 09 62 19: Laminate Flooring
CSI MasterFormat 12 36 23.13: Plastic-Laminate-Clad Countertops

11

MECHANICAL & ELECTRICAL SYSTEMS

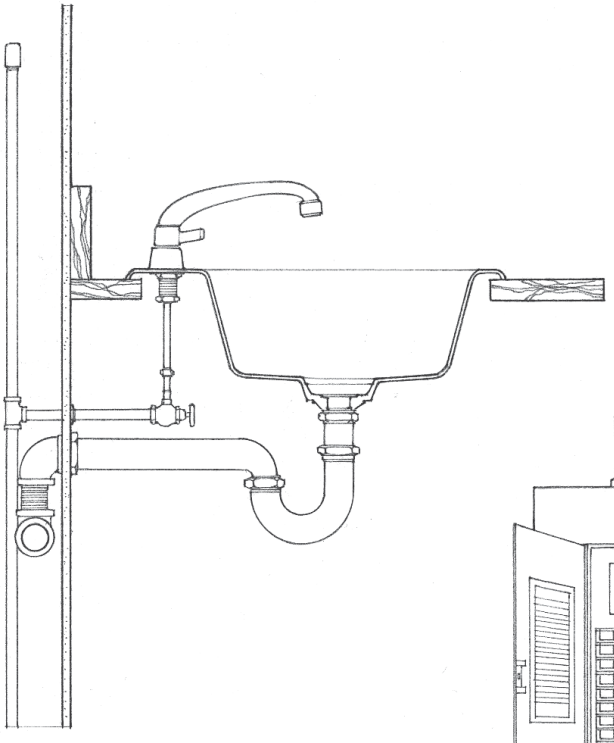
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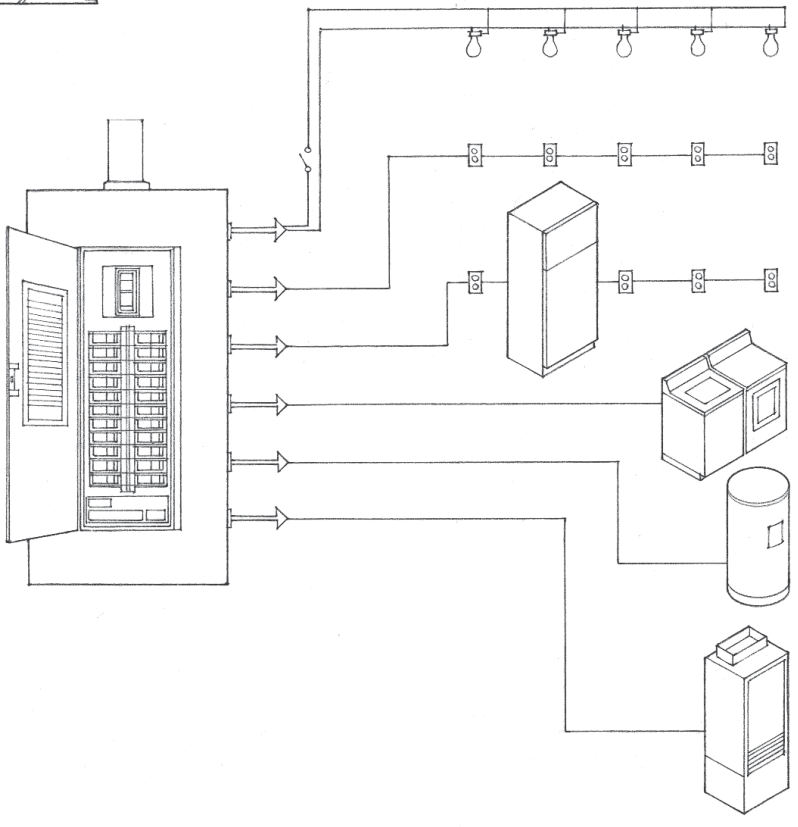


This chapter discusses the mechanical and electrical systems that are required to maintain the necessary conditions of environmental comfort, health, and safety for the occupants of a building. The intent is not to provide a complete design manual but to outline those factors that should be considered for the successful operation of these systems and their integration with other building systems.

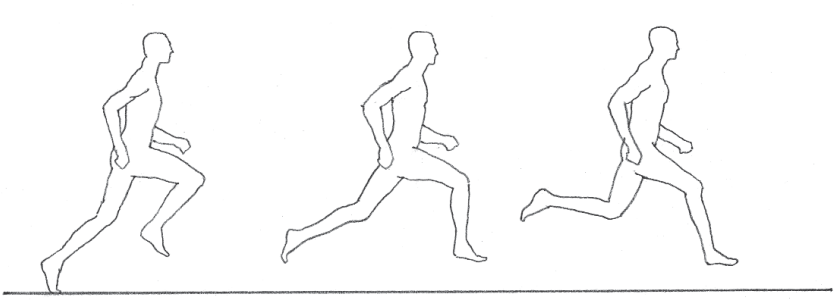
Heating, ventilating, and air-conditioning systems condition the interior spaces of a building for the environmental comfort of the occupants. A potable water supply is essential for human consumption and sanitation. The efficient disposal of fluid waste and organic matter is necessary in order to maintain sanitary conditions within a building and in the surrounding area. Electrical systems furnish light and heat for a building's occupants, and power to run its machines.

These systems require a significant amount of space. Because much of the hardware for these systems is normally hidden from view—within concealed construction spaces or special rooms—the layout of these systems should be carefully integrated with each other as well as with the structural and enclosure systems of the building.





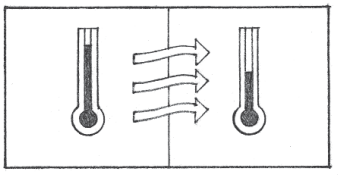
At rest, the human body produces about 400 Btu/h (117 W) of energy. Moderate activities like walking can raise this amount to 750 Btu/h (220 W), while strenuous activities can cause the body to generate up to 1200 Btu/h (351 W). Thermal comfort is achieved when the human body is able to dissipate the heat and moisture it produces by metabolic action in order to maintain a stable, normal body temperature. In other words, thermal equilibrium must exist between the body and its environment.

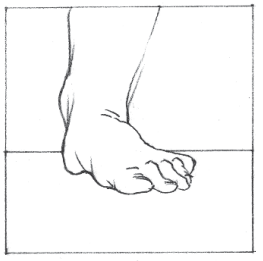


The human body loses or transfers heat to the surrounding air and surfaces in the following ways.

Conduction

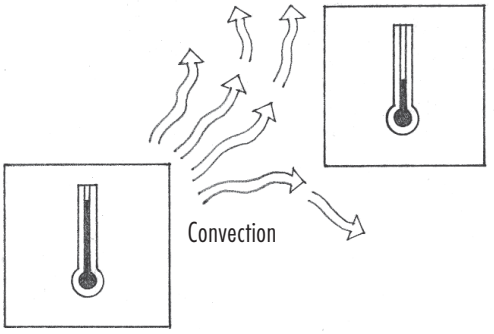
- Conduction is the transfer of heat from the warmer to the cooler particles of a medium or of two bodies in direct contact, occurring without perceptible displacement of the particles themselves.
- Conduction accounts for a very small portion of the total heat loss from the body.





Convection

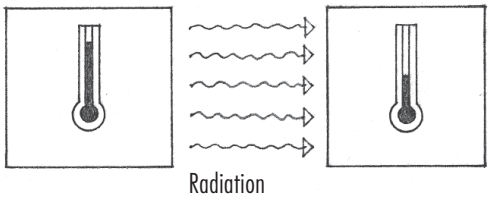
- Convection is the transfer of heat by the circulatory motion of the heated parts of a liquid or gas owing to a variation in density and the action of gravity. In other words, the body gives off heat to the surrounding cooler air.
- A large differential between air and skin temperature and increased air motion induce more heat transmission by convection.

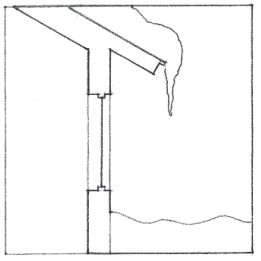




Radiation

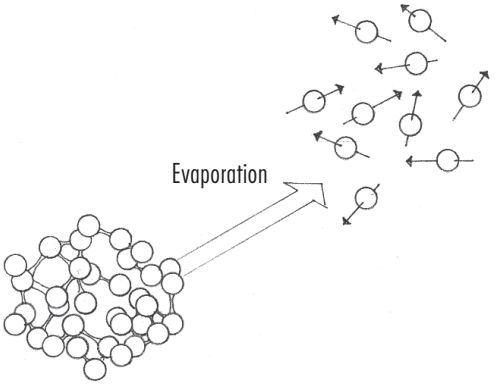
- Radiation is the process by which heat energy in the form of electromagnetic waves is emitted by a warm body, transmitted through an intervening space, and absorbed by a cooler body. No air motion is required for the transfer of heat.
- Light colors reflect while dark colors absorb heat; poor reflectors make good radiators.
- Radiant heat cannot travel around corners and is not affected by air motion.





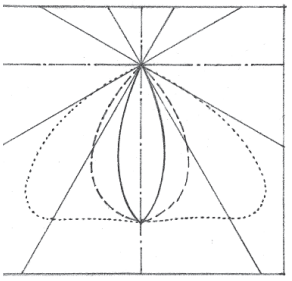
Evaporation

- Heat is required for the evaporative process of converting body moisture into a vapor.
- Heat loss by evaporation increases with air motion.
- Evaporative cooling is especially beneficial when high air temperatures, humidity, and activity levels exist.





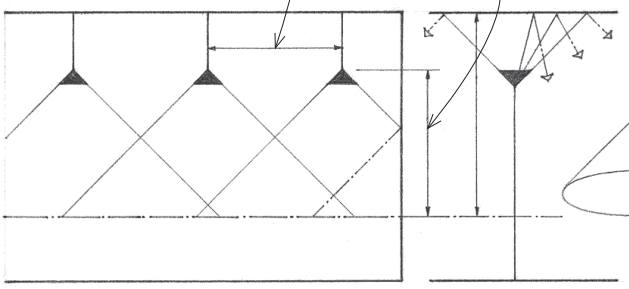
- Beam spread is the angle of a light beam that intersects the candlepower distribution curve at points where the luminous intensity equals a stated percent of a maximum reference intensity.



Spacing criteria is a formula for determining how far apart luminaires may be installed for uniform lighting of a surface or area, based on mounting height.

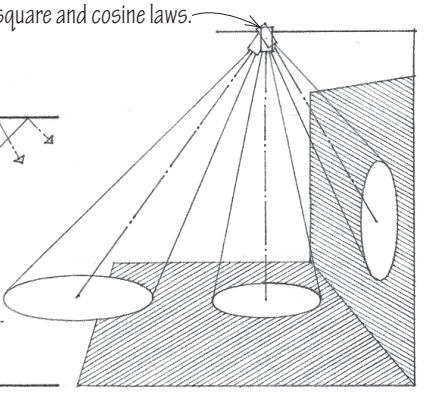
- Spacing criteria (SC) = Spacing (S)/Mounting Height (MH)

SC = 0.5
SC = 1.0
SC = 1.5

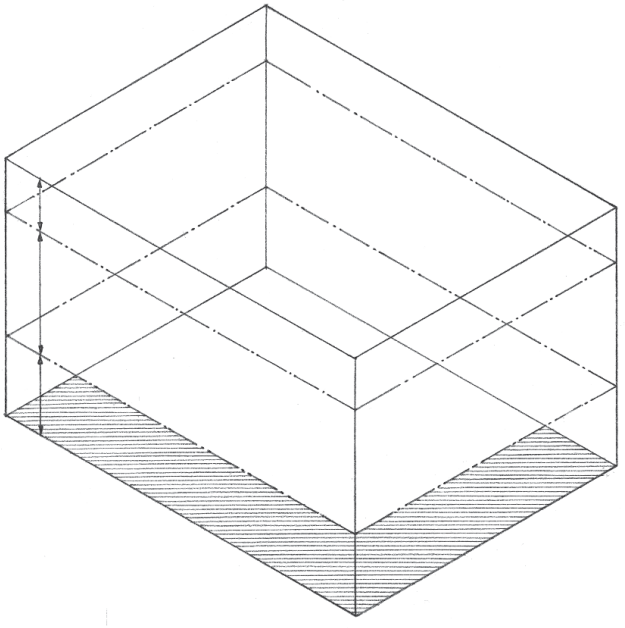


- S/MH ratios are calculated and supplied by the luminaire manufacturer.

The point method is a procedure for calculating the illumination produced on a surface by a point source from any angle, based on the inverse square and cosine laws.



- Ceiling cavity is formed by a ceiling, a plane of suspended luminaires, and wall surfaces between these two planes.
- Room cavity is formed by a plane of luminaires, the work plane, and the wall surfaces between these two planes.
- Floor cavity is formed by the work plane, the floor, and the wall surfaces between these two planes.



The lumen method, also called the zonal cavity method, is a procedure for determining the number and types of lamps, luminaires, or windows required to provide a uniform level of illumination on a work plane, taking into account both direct and reflected luminous flux.

- Work plane is the horizontal plane at which work is done and on which illumination is specified and measured, usually assumed to be 30" (762) above the floor.

- Room cavity ratio is a single number derived from the dimensions of a room cavity for use in determining the coefficient of utilization.
- Coefficient of utilization (CU) is the ratio of the luminous flux reaching a specified work plane to the total lumen output of a luminaire, taking into account the proportions of a room and the reflectances of its surfaces.

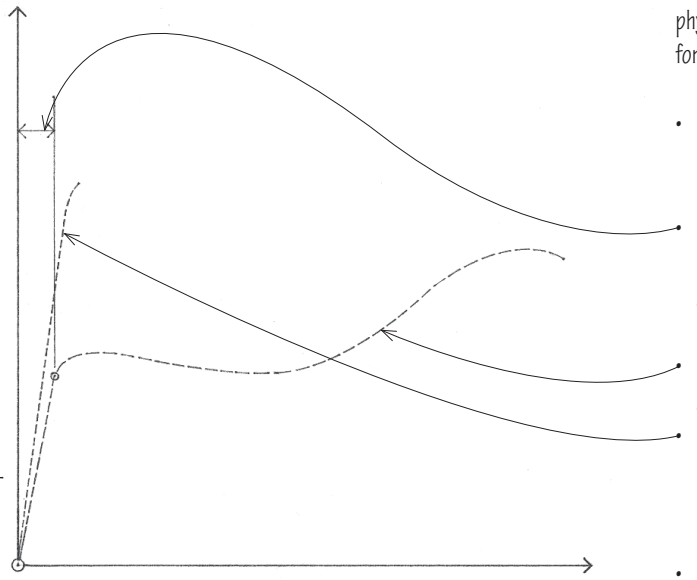
- Light loss factor is any of several factors used in calculating the effective illumination provided by a lighting system after a given period of time and under given conditions.
- Recoverable light loss factors (RLLF) may be recovered by relamping or maintenance.
  - Lamp lumen depreciation represents the decrease in luminous output of a lamp during its operating life, expressed as a percentage of initial lamp lumens.
  - Luminaire dirt depreciation represents the decrease in luminous output of a luminaire resulting from the accumulation of dirt on its surfaces, expressed as a percentage of the illumination from the luminaire when new or clean.
  - Room surface dirt depreciation represents the decrease in reflected light resulting from the accumulation of dirt on a room's surfaces, expressed as a percentage of the light reflected from the surfaces when clean.
- Nonrecoverable light loss factor (NRLLF) is any of several permanent light loss factors that take into account the effects of temperature, voltage drops or surges, ballast variations, and partition heights.

- Average maintained illuminance $= \dfrac{\text{Initial lamp lumens}^* \times \text{CU} \times \text{RLLF} \times \text{NRLLF}}{\text{Work area}}$

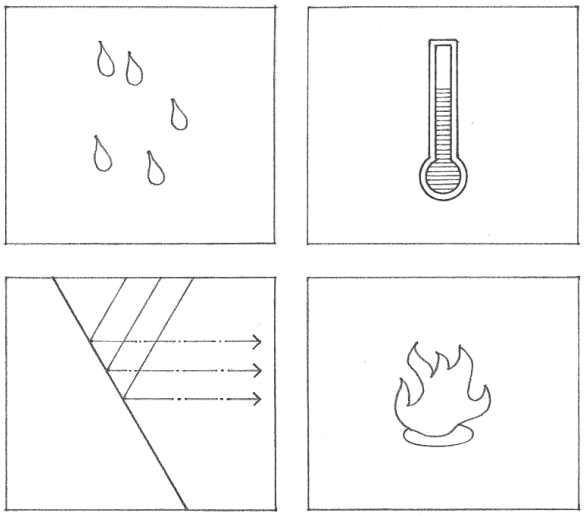
* Initial lamp lumens = lumens per lamp × lamps per luminaire

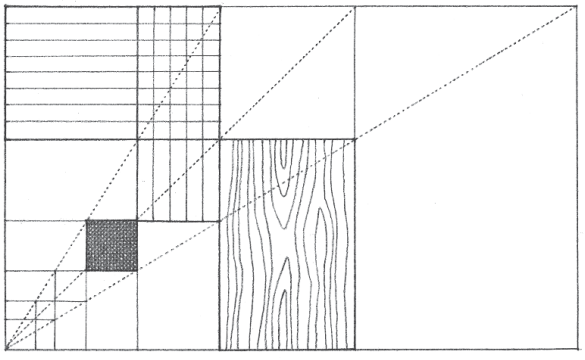
12
NOTES ON MATERIALS

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- Stress: the internal resistance or reaction of an elastic body to external forces applied to it, expressed in units of force per unit of cross-sectional area.
- Strain: the deformation of a body under the action of an applied force, equal to the ratio of the change in size or shape to the original size or shape of a stressed element





This chapter describes the major types of building materials, their physical properties, and their uses in building construction. The criteria for selecting and using a building material include those listed below.

- Each material has distinct properties of strength, elasticity, and stiffness. The most effective structural materials are those that combine elasticity with stiffness.
- Elasticity is the ability of a material to deform under stress—bend, stretch, or compress—and return to its original shape when the applied stress is removed. Every material has its elastic limit beyond which it will permanently deform or break.
- Materials that undergo plastic deformation before actually breaking are termed ductile.
- Brittle materials, on the other hand, have low elastic limits and rupture under loads with little visible deformation. Because brittle materials have less reserve strength than ductile materials, they are not as suitable for structural purposes.
- Stiffness is a measure of the extent to which an elastic body resists deformation. The stiffness of a solid body is dependent on its structural shape as well as the elasticity of its material and is an important factor when considering the relationship between span and deflection under loading.

- The dimensional stability of a material as it responds to changes in temperature and moisture content affects the manner in which it is detailed and constructed to join with other materials.
- The resistance of a material to water and water vapor is an important consideration when it is exposed to weather or used in moist environments.
- The thermal conductivity or resistance of a material must be assessed when it is used in constructing the exterior envelope of a building.

- A material's transmission, reflection, or absorption of visible light and radiant heat should be evaluated when the material is used to finish the surfaces of a room.
- The density or hardness of a material determines its resistance to wear and abrasion, its durability in use, and the costs required to maintain it.

- The ability of a material to resist combustion, withstand exposure to fire, and not produce smoke and toxic gases, must be evaluated before using it as a structural member or an interior finish.

- The color, texture, and scale of a material are obvious considerations in evaluating how it fits within the overall design scheme.
- Many building materials are manufactured in standard shapes and sizes. These stock dimensions, however, may vary slightly from one manufacturer to the next. They should be verified in the planning and design phases of a building so that unnecessary cutting or wasting of material can be minimized during construction.

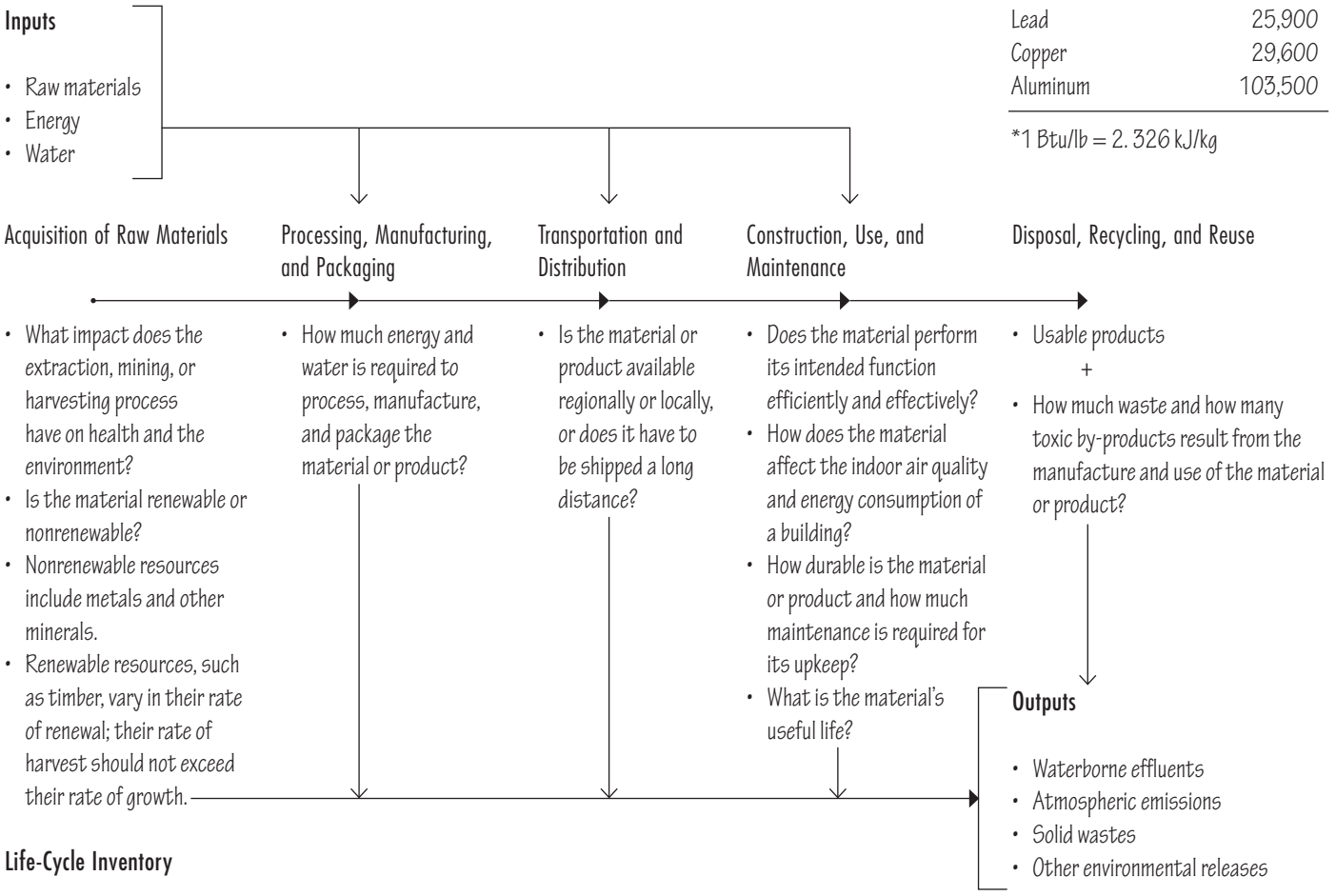
The evaluation of building materials should extend beyond their functional, economic, and aesthetic aspects and include assessing the environmental consequences associated with their selection and use. This examination, called a life-cycle assessment, encompasses the extraction and processing of raw materials, the manufacturing, packaging, and transportation of the finished product to the point of use, maintaining the material in use, the possible recycling and reuse of the material, and its final disposal. This assessment process consists of three components: inputs, life-cycle inventory, and outputs.

- Embodied energy includes all of the energy expended during the life cycle of a material.
- Refer to the *Environmental Resource Guide*, a project of the American Institute of Architects, for more information.

Embodied Energy in Building Materials

Material	Energy Content Btu/lb.*
Sand & gravel	18
Wood	185
Lightweight concrete	940
Gypsum board	1830
Brickwork	2200
Cement	4100
Glass	11,100
Plastic	18,500
Steel	19,200
Lead	25,900
Copper	29,600
Aluminum	103,500

*1 Btu/lb = 2. 326 kJ/kg

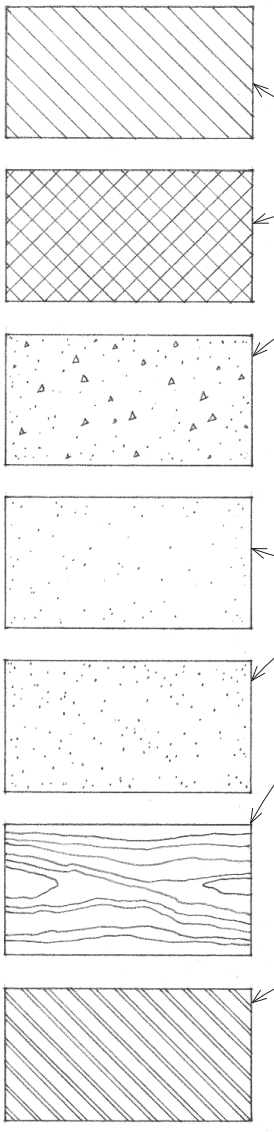


Life-Cycle Inventory

Evaluating the choice of a building material is a complex matter that cannot be reduced to a simple formula yielding a precise and valid answer with certainty. For example, using less of a material with a high energy content may be more effective in conserving energy and resources than using more of a lower-energy material. Using a higher-energy material that will last longer and require less maintenance, or one that can be recycled and reused, may be more compelling than using a lower-energy material.

Reduce, reuse, and recycle best summarize the kinds of strategies that are effective in achieving the goal of sustainability.

- Reduce building size through more efficient layout and use of spaces.
- Reduce construction waste. LEED® MR Credit 5: Construction and Demolition Waste Management
- Specify products that use raw materials more efficiently. LEED MR Credit 3: Building Product Disclosure and Optimization—Sourcing of Raw Materials
- Substitute plentiful resources for scarce resources. LEED MR Credit 4: Building Product Disclosure and Optimization—Material Ingredients
- Reuse building materials from demolished buildings. LEED MR Credit 1: Building Life-Cycle Impact Reduction
- Rehabilitate existing buildings for new uses. LEED MR Credit 1: Building Life-Cycle Impact Reduction
- Recycle new products from old. LEED MR Credit 1: Building Life-Cycle Impact Reduction



All materials to receive paint or other coating must be properly prepared and primed to ensure adhesion of the coating to their surfaces and to maximize the life of the coating. In general, surfaces should be dry and free of contaminants, such as dirt, grease, moisture, and mildew. The following are recommendations for various materials:

- Brick surface should have dirt, loose mortar, efflorescence, and other foreign matter removed by wire brushing, air pressure, or steam cleaning. Seal with a latex primer-sealer or a clear silicone water-repellant.
- Concrete masonry should be thoroughly dry and free of dirt and loose or excess mortar. Porous surfaces may require a block filler or cement grout primer if the acoustical value of a rough surface is not important.
- Concrete surface should be well-cured and free of dirt, form oils, and curing compounds. Porous surfaces may require a block filler or cement grout primer. Prime grouted surfaces with a latex, alkyd, or oil primer-sealer. Concrete surfaces may also be sealed with a clear silicone water repellant.
- Concrete floors should be free of dirt, wax, grease, and oils, and should be etched with a muriatic acid solution to improve adhesion of the coating. Prime with an alkali-resistant coating.
- Gypsum board surfaces should be clean and dry. Use a latex primer-sealer to avoid raising the fibers of the paper surface.
- Plaster and stucco surfaces should be allowed to dry thoroughly and be completely cured. Prime with a latex, alkyd, or oil primer-sealer. Fresh plaster should be primed with an alkali-resistant coating.
- Wood should be clean, dry, well-seasoned lumber. Knots and pitch stains should be sanded and sealed before priming. Surfaces to be painted should be primed or sealed to stabilize the moisture content of the wood and prevent the absorption of succeeding coats; stains and some paints may be self-priming. All nail holes, cracks, and other small holes should be filled after the prime coat.
- Old paint surfaces should be clean, dry, and roughened by sanding or washing with a detergent solution.
- Ferrous metal surfaces should be free of rust, metal burrs, and foreign matter. Clean with solvents or by wire brushing, sandblasting, flame cleaning, or pickling with acids. Prime with a rust-inhibitive primer.
- Galvanized iron should have all grease, residue, and corrosion removed with a solvent or chemical wash. Prime with a zinc oxide or portland cement paint. If weathered, galvanized iron should be treated as a ferrous metal.

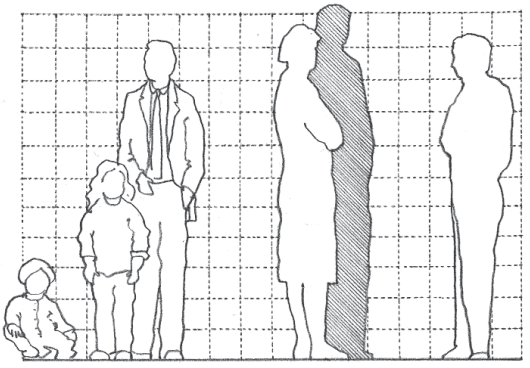
In addition to the surface preparation and priming required, other considerations in the selection of a coating include:

- Compatibility of the coating with the surface to which it is applied
- The method of application and drying time required
- Conditions of use and the required resistance to water, heat, sunlight, temperature variation, mildew, chemicals, and physical abrasion
- The possible emission of harmful volatile organic compounds

A
APPENDIX

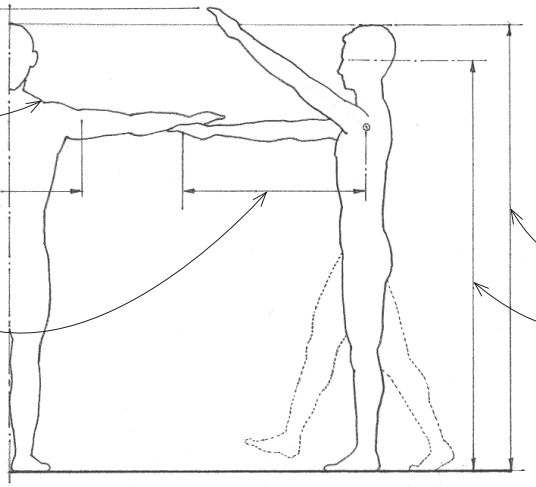
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A.27 Professional & Trade Associations

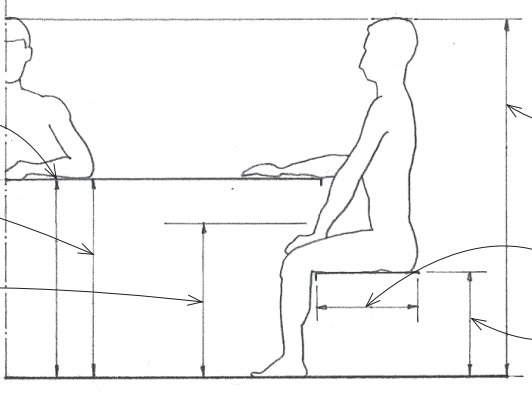
A.02 HUMAN DIMENSIONS

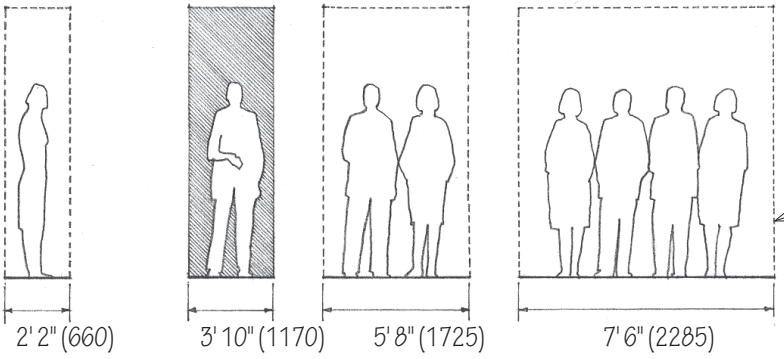


Our body dimensions, and the way we move through and perceive space, are prime determinants of the scale, proportions, and spatial layout of a building. It should be noted that there is a difference between the structural dimensions of our bodies and those dimensional requirements that result from how we reach for something on a shelf, sit down at a table, walk down a stairway, or interact with other people. These functional dimensions will vary according to the nature of our activity and the social situation.

Caution should always be exercised when using a set of dimensional tables or illustrations such as these. These are based on average measurements, which may have to be adjusted to satisfy specific user needs. Variations from the norm will always exist due to the differences between men and women, among various age and racial groups, and from one individual to the next.







The *Americans with Disabilities Act* (ADA) of 1990 is federal civil-rights legislation requiring that buildings be accessible to persons with physical disabilities and certain defined mental disabilities. The *ADA Accessibility Guidelines* (*2010 ADA Standards for Accessible Design*) are maintained by the U.S. Access Board, an independent federal agency, and the regulations are administered by the U.S. Department of Justice. Federal facilities must comply with standards issued under the *Architectural Barriers Act* (ABA). In its last update, the Access Board harmonized the ADA guidelines with its guidelines for facilities covered by the ABA and published them jointly as the *ADA-ABA Accessibility Guidelines*. Related legislation includes the Federal Fair Housing Act (FFHA) of 1988, which contains Department of Housing and Urban Development (HUD) regulations requiring residential complexes of four or more dwelling units to be adaptable for use by persons with disabilities.

Facilities should be accessible to both those using wheelchairs and the ambulatory.

- Accessible routes consist of walking surfaces with a maximum slope of 1:20, marked crossings at vehicular roadways, clear floor space at accessible elements, access aisles, ramps, curb ramps, and elevators.
- Floor surfaces should be firm, stable, and slip-resistant.
- Avoid changes in level and the use of stairs.
- Use ramps only where necessary.

Facilities should be identifiable to the blind.

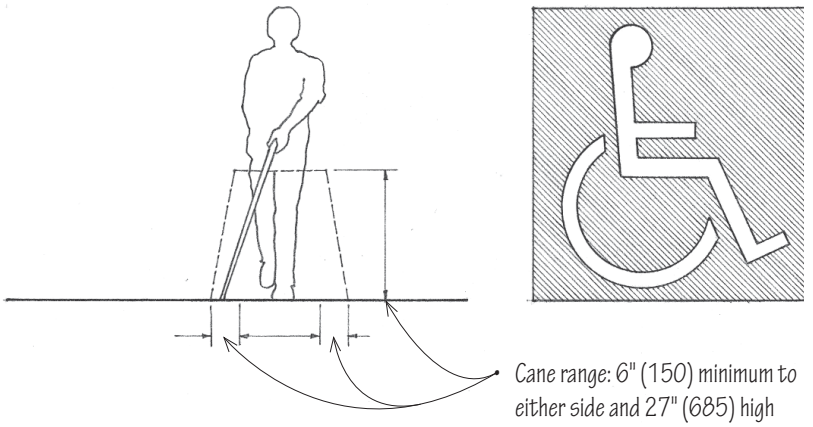
- Use raised lettering, audible warning signals, and textured surfaces to indicate stairs or hazardous openings.

Facilities should be usable.

- Circulation spaces should be adequate for comfortable movement.
- All public facilities should have fixtures designed for use by persons with disabilities.

For ADA Accessibility Guidelines for other building elements or components, see the following:

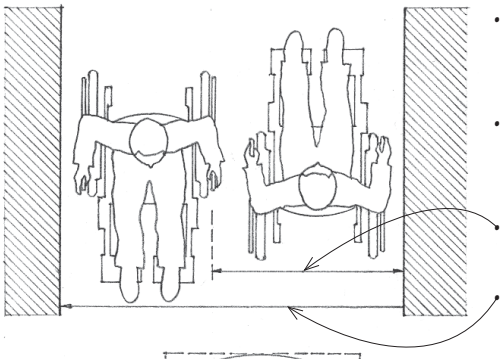
- Vehicular parking: 1.33
- Doors: 8.03
- Door hardware: 8.17, 8.19, 8.20
- Thresholds: 8.21
- Windows: 8.22
- Stairs and ramps: 9.05
- Elevators: 9.16
- Kitchens: 9.22–9.23
- Toilet and bathing facilities: 9.26, 9.28
- Carpeting: 10.21



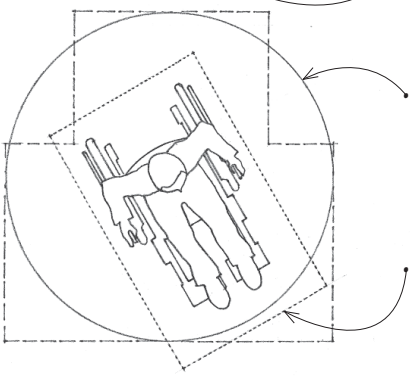
Cane range: 6" (150) minimum to either side and 27" (685) high



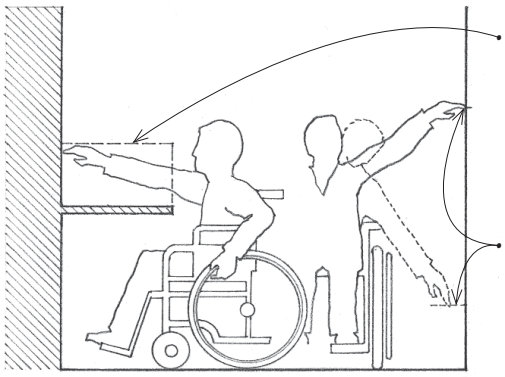
- Up to a 1/4" (6) change in level may be vertical.
- Changes in level from 1/4" to 1/2" (6 to 13) should be beveled with a slope not steeper than 1:2.
- Changes in level greater than 1/2" (13) must be ramped.



- 36" (915) minimum clear width for passage
- 60" (1525) minimum clear width for two wheelchairs to pass



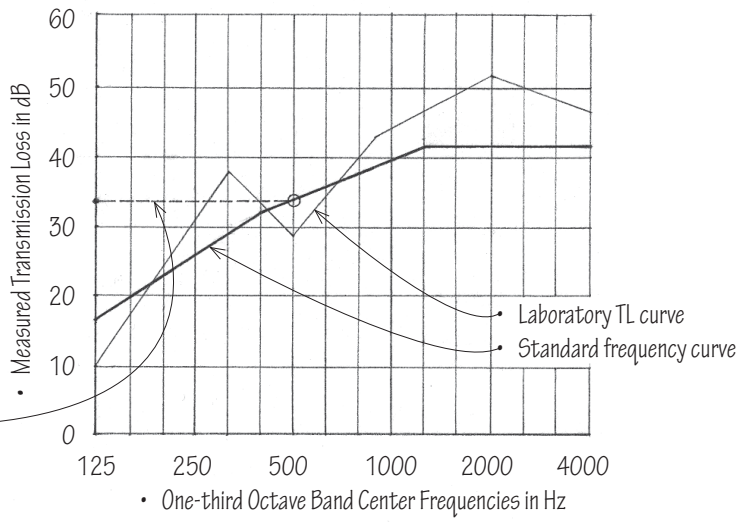
- 60" (1525) minimum clear ø, or a T-shaped space with arms at least 36" (915) wide and 60" (1525) long, to allow a wheelchair to turn
- 30" × 48" (760 × 1220) minimum clear floor space required for either forward or parallel approach to an object

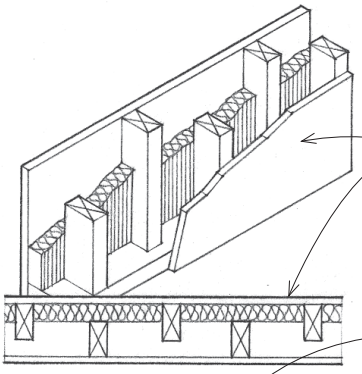


- Maximum reach height of 48" (1220) for reach depths up to 20" (510); maximum reach height of 44" (1120) for reach depths from 20" to 25" (510 to 635)
- 54" (1370) maximum and 15" (380) minimum side reach above the floor

Transmission Loss

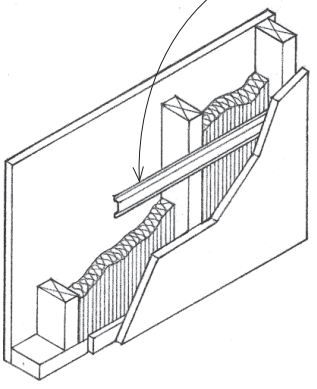
- Transmission loss (TL) is a measure of the performance of a building material or construction assembly in preventing the transmission of airborne sound, equal to the reduction in sound intensity as it passes through the material or assembly when tested at all 1/3 octave band center frequencies from 125 to 4000 Hz: expressed in decibels.
- Average TL is a single-number rating of the performance of a building material or construction assembly in preventing the transmission of airborne sound, equal to the average of its TL values at nine test frequencies.
- Sound transmission class (STC) is a single-number rating of the performance of a building material or construction assembly in preventing the transmission of airborne sound, derived by comparing the laboratory TL test curve for the material or assembly to a standard frequency curve. The higher the STC rating, the greater the sound-isolating value of the material or construction. An open doorway has an STC rating of 10; normal construction has STC ratings from 30 to 60; special construction is required for STC ratings above 60.

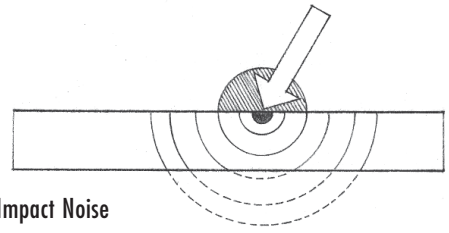




Three factors enhance the TL rating of a construction assembly: separation into layers, mass, and absorptive capacity.

- Staggered-stud partitions for reducing sound transmission between rooms are framed with two separate rows of studs arranged in zigzag fashion and supporting opposite faces of the partition, sometimes with a fiberglass blanket between.
- Resilient mounting is a system of flexible supports or attachments, such as resilient channels and clips, that permits room surfaces to vibrate normally without transmitting the vibratory motions and associated noise to the supporting structure.
- Air spaces increase transmission loss.
- Seal pipe penetrations and other openings and cracks in walls and floors to maintain the continuity of sound isolation.





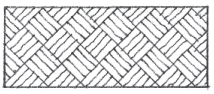
Impact Noise

Impact noise is structure-borne sound generated by physical impact, as by footsteps or the moving of furniture.

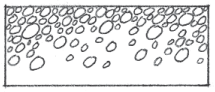
- Impact insulation class (IIC) is a single-number rating of the performance of a floor-ceiling construction in preventing the transmission of impact noise. The higher the IIC rating, the more effective is the construction in isolating impact noise. The IIC rating replaces the previously used Impact Noise Rating (INR) and is approximately equal to the INR rating + 51 dB for a given construction.

- Acoustic mass resists the transmission of sound by the inertia and elasticity of the transmitting medium. In general, the heavier and more dense a body, the greater its resistance to sound transmission.
- Absorption coefficient is a measure of the efficiency of a material in absorbing sound at a specified frequency, equal to the fractional part of the incident sound energy at that frequency absorbed by the material.

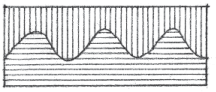
Earthwork



• Earth

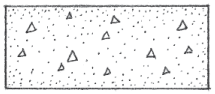


• Gravel

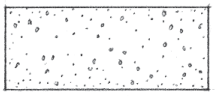


• Rock

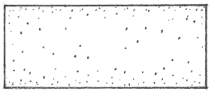
Concrete



• Cast-in-place/precast

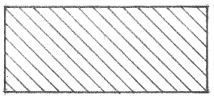


• Grout

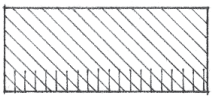


• Mortar

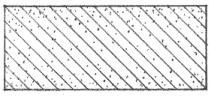
Masonry



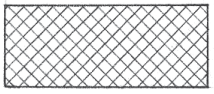
• Brick



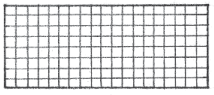
• Firebrick



• Adobe/rammed earth

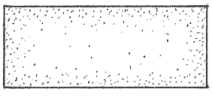


• Concrete block

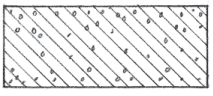


• Structural facing tile

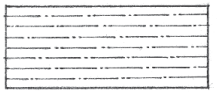
Stone



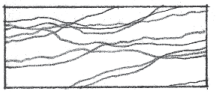
• Cut stone



• Rubble

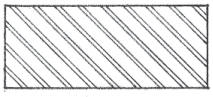


• Slate

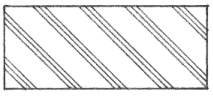


• Marble

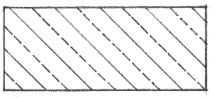
Metal



• Steel

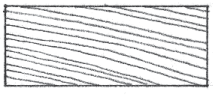


• Aluminum

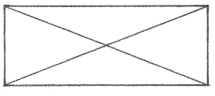


• Brass/bronze

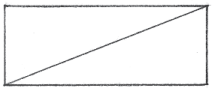
Wood



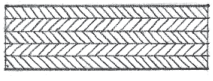
• Finish



• Rough



• Blocking

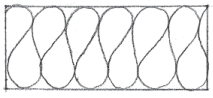


• Plywood – large scale

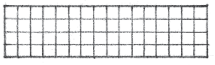


• Plywood – small scale

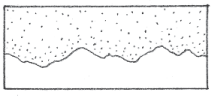
Insulation



• Batt/loose fill insulation



• Rigid insulation



• Spray/foam insulation

Glass

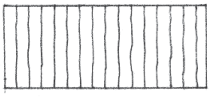


• Glass

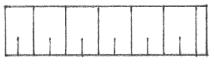


• Glass block

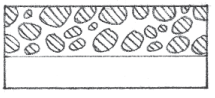
Finishes



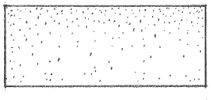
• Ceramic tile



• Acoustical tile



• Terrazzo



• Plaster



• Carpeting



• Plastic laminate

The Construction Specifications Institute (CSI) created *MasterFormat*® to standardize information about construction requirements, products, and activities, and facilitate communication among architects, contractors, specifiers, and suppliers. *MasterFormat*® is the most widely adopted specification-writing standard for commercial design and construction projects in North America.

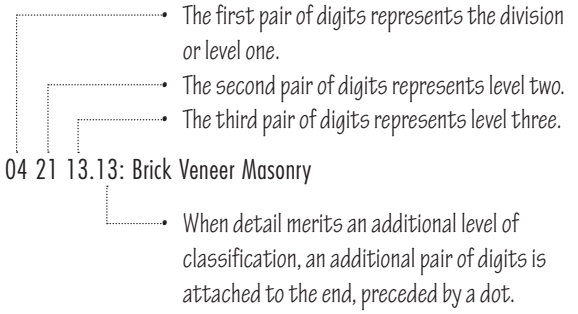
Along with her sister organization, Construction Specifications Canada (CSC), CSI issued a new edition of *MasterFormat*® in 2004 that adopted a six-digit numbering scheme to provide more flexibility and room for expansion than the five-digit numbers of the 1995 edition could provide. The 2004 edition also increased from 16 to 50 divisions to reflect innovations in and growing complexity of the construction industry, such as Building Information Modeling (BIM), life-cycle costing, and issues of pollution, remediation, and maintenance. Updates have been published in 2010, 2012, and 2016.

MasterFormat® organizes a master list of section numbers and subject titles into two major groups: the Procurement and Contracting Requirements Group (Division 00) and the Specifications Group, which is further subdivided into five subgroups:

- General Requirements Subgroup: Division 01
- Facility Construction Subgroup: Divisions 02 through 19
- Facility Services Subgroup: Divisions 20 through 29
- Site and Infrastructure Subgroup: Divisions 30 through 39
- Process Equipment Subgroup: Divisions 40 through 49

There are a total of 50 level-one titles or divisions, some of which are held in reserve for future use. Each division consists of sections defined by a number and title and arranged in levels depending on their breadth and depth of coverage.

SPECIFICATIONS GROUP
Facility Construction Subgroup
DIVISION 04 – MASONRY



PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP
DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS
00 10 00 Solicitation
00 20 00 Instructions for Procurement
00 30 00 Available Information
00 40 00 Procurement Forms and Supplements
00 50 00 Contracting Forms and Supplements
00 60 00 Project Forms
00 70 00 Conditions of the Contract
00 80 00 Unassigned
00 90 00 Revisions, Clarifications, and Modifications

SPECIFICATIONS GROUP
General Requirements Subgroup
DIVISION 01 – GENERAL REQUIREMENTS
01 00 00 General Requirements
01 10 00 Summary
01 20 00 Price and Payment Procedures
01 30 00 Administrative Requirements
01 40 00 Quality Requirements
01 50 00 Temporary Facilities and Controls
01 60 00 Product Requirements
01 70 00 Execution and Closeout Requirements
01 80 00 Performance Requirements
01 90 00 Life-Cycle Activities

Facility Construction Subgroup
DIVISION 02 – EXISTING CONDITIONS
02 00 00 Existing Conditions
02 10 00 Unassigned
02 20 00 Assessment
02 30 00 Subsurface Investigation
02 40 00 Demolition and Structure Moving
02 50 00 Site Remediation
02 60 00 Contaminated Site Material Removal
02 70 00 Water Remediation
02 80 00 Facility Remediation
02 90 00 Unassigned

DIVISION 03 – CONCRETE
03 00 00 Concrete
03 10 00 Concrete Forming and Accessories
03 20 00 Concrete Reinforcing
03 30 00 Cast-in-Place Concrete
03 40 00 Precast Concrete
03 50 00 Cast Decks and Underlayment
03 60 00 Grouting
03 70 00 Mass Concrete
03 80 00 Concrete Cutting and Boring
03 90 00 Unassigned