Architectural Detailing

Function • Constructibility • Aesthetics

Third Edition

Edward Allen and Patrick Rand

WILEY

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INTRODUCTION

The transition from architectural idea to built reality is composed of countless decisions that are made amid a landscape of ever-changing circumstances. Architects design and draw for each building a set of details that show how it will be put together. Architects have primary responsibility for the detailing in buildings, a fact that architectural curricula often underappreciate. Detailing should be at least as prominent in architecture curricula as structures and mechanical systems: two areas in which consulting engineers often have primary responsibility. This book is intended to help students and young professionals become proficient with architectural detailing.

How does the architect know if these details will achieve the desired result? Will the building that they represent go together easily and economically? Will it shed water? Will it be easy to heat and cool? Will the details look good with one another and with the overall form and space of the building? Will the building grow old gracefully, and will it last for the requisite period of time? There are many more questions of similar importance.

The experienced architect does not leave the answers to chance. Each detail, no matter how special or unprecedented, is designed in conformance with universal, timeless patterns that, given competent execution on the construction site, virtually guarantee satisfactory building performance. These detail patterns are the subject of this book.

Detail patterns are elemental principles that are present in all successful building details. They represent an accumulation of centuries of wisdom about what works in building construction and what does not. Many of the patterns are firmly grounded in scientific fact. Others are based just as solidly on common sense and the realities of human performance. The experienced architect employs all these patterns automatically, as if by instinct, when designing details.

Good detailing is an opportunity to advance the concepts and aesthetic themes of the basic design. The detail patterns can be used to edit the schematic design, celebrating its strengths and eliminating features that are not contributing to the central ideas.

The patterns clarify the issues relevant to a particular detail but avoid stating what the solution should be. They are meant to provoke the designer to discover many possible solutions and to provide a clear process through which each can be assessed.

Details are rarely designed from scratch, as a pure response to a situation, as if it had never existed before. More often, we build upon precedents. The architect uses the detail patterns as a reliable means of analyzing and understanding existing details. They are helpful in reviewing one's own work, in checking the work of other detailers in the office, in judging the quality of manufactured building components, and in diagnosing problems in existing buildings. The absence of attention to a particular detail pattern, or the presence of a feature that contradicts a pattern, usually indicates a problem or a potential problem that should be corrected.

The detail patterns are straightforward and easy to learn. There are slightly more than 100 of them. Each is irreducibly simple.

The first portion of this book introduces each of the patterns in turn, explains it, and illustrates several instances of its use. Each pattern is given a simple descriptive name and a graphical icon to assist in the memorization of it.

The patterns are arranged in three main groups: Function, Constructibility, and Aesthetics, corresponding to the three major concerns of the detailer. The order of presentation of these groups is not intended to imply their hierarchy or their sequence in the design process. Under each of these groupings, the patterns are further categorized by similarity of intent. The first category of patterns under Function, for example, is Controlling Water Leakage, comprising 13 detail patterns that offer a complete strategy for accomplishing this important task.

The second portion of the book demonstrates the use of the detail patterns during the process of designing the details of three different hypothetical buildings: one in wood, one in architectural concrete, and one in brick veneer over a reinforced concrete frame.

The book closes with an annotated listing of publications recommended for the detailer's own reference shelf and a list of websites of particular interest. Exercises for self-study or classroom use are also provided.

The almost 500 original sketches and drawings by the authors are intended to be illustrative of the building elements and natural phenomena being addressed. They are not working drawings. Almost all are freehand sketches, because this remains the primary means that designers use to begin creating details. Some information has been intentionally deleted or added to make the drawings effective instructional tools. For instance, anchors securing a masonry veneer to the backup are drawn in these sections, whereas they might be identified only in specifications or in a large-scale detail in a set of working drawings produced in an office. By including them in the sketches, readers will engage the visual reality in more complete terms.

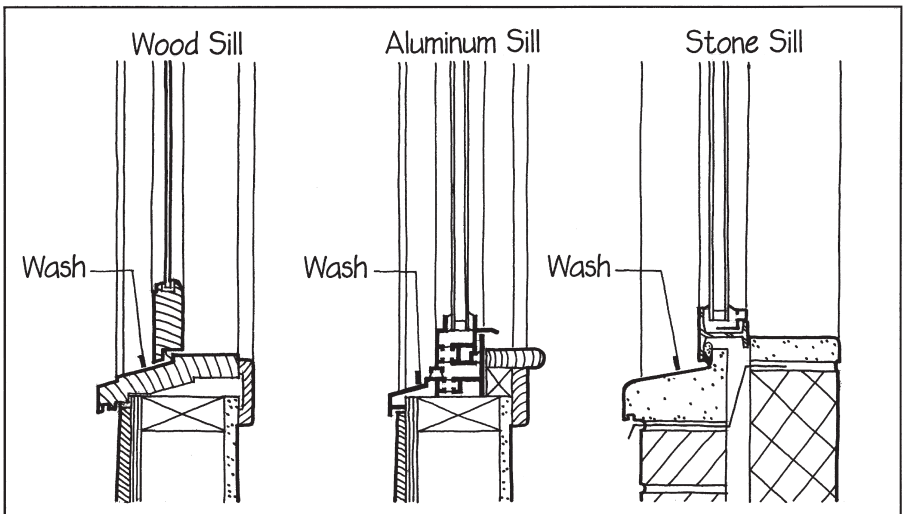
It is assumed that the reader has a general background in the materials and methods of building construction and is familiar with the conventions of architectural drawing. In the detail drawings throughout the book, outdoors is always to the left or top of the drawing.

Wash

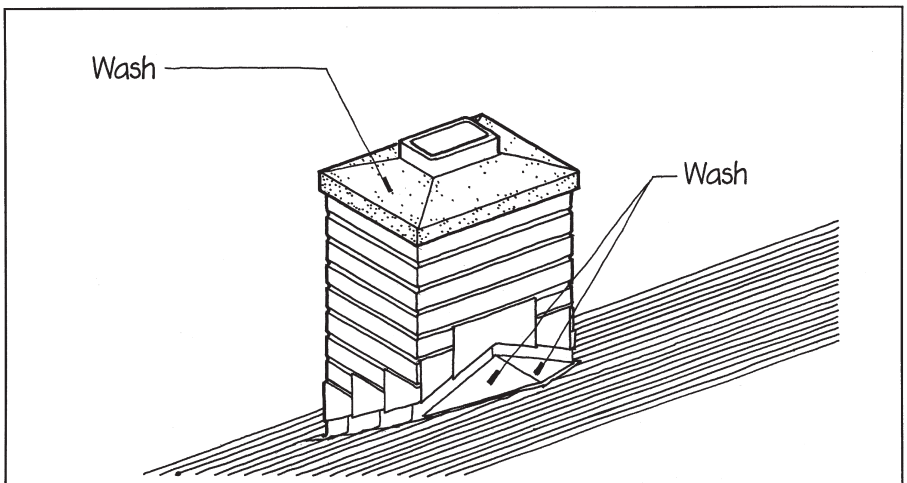
A WASH is a slope given to a horizontal surface to drain water away from vulnerable areas of a building. In general, every external horizontal surface of a building should have a wash. More permeable materials should have a steeper slope to shed water more quickly.

1. A window or door sill, whether made of stone, concrete, wood, or metal, always has a wash to keep water from accumulating next to the door or sash. A minimum slope for this type of wash is about 1 in. per foot (1:10 or 1:12). A steeper slope drains water faster and is more secure, because the more quickly water is removed from a surface, the less time it has to leak through. It is also more difficult for wind to drive water up a steeper slope.

2. The wash on this concrete chimney cap keeps water away from the vulnerable crack between the clay flue tile and the concrete. The slope should be at least 1:12. The outer edge of the cap should have a thickness of at least 3 in. (75 mm) to discourage cracking of the concrete, not the feather edge that is commonly used (see ***Clean Edge***, Chapter 12). The cricket on the upslope side of the chimney consists of two washes that divert water around the shaft of the chimney. ▷



1. Washes on Window Sills



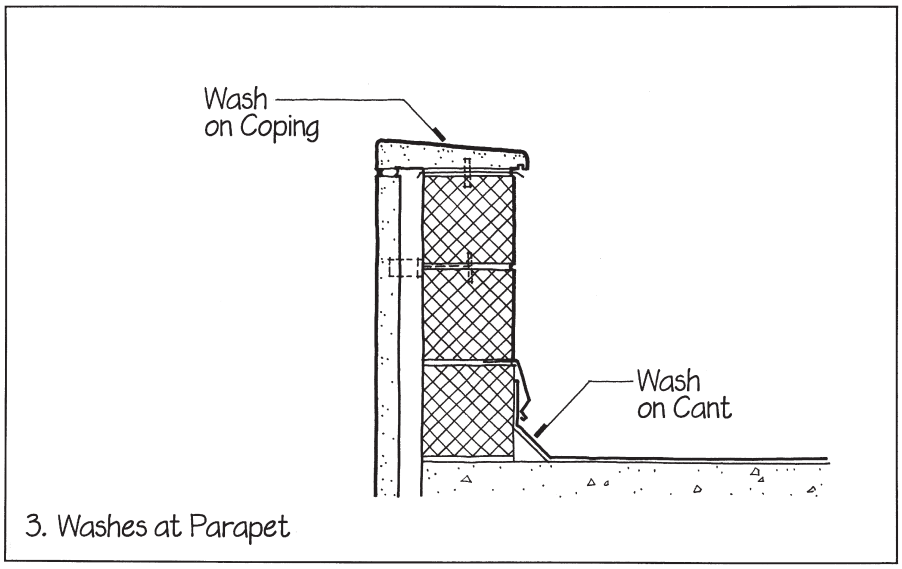
2. Wash on Chimney Cap and Cricket

3. The coping on a building parapet has a wash to keep standing water away from the seams in the parapet. Usually the wash drains toward the roof, to minimize water staining of the building faces. The cant strip at the base of the parapet slopes steeply toward the roof membrane to direct water away from the joint between the parapet and the roof deck.

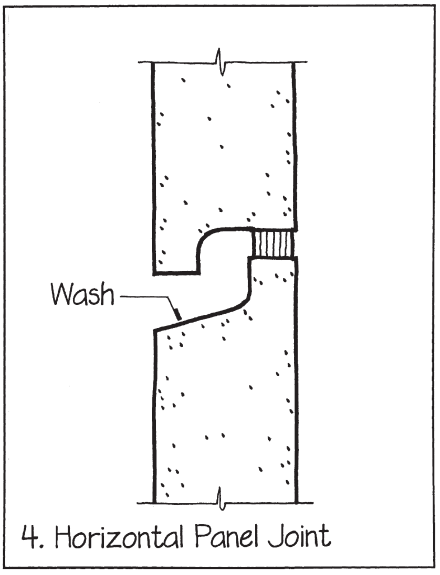
4. The bottom surface in a horizontal joint between wall panels should have a wash to drain water to the outside. Even if the joint will be closed at the outside face with sealant, the wash should be provided to discourage leaking if the sealant should fail.

5. The sloping roof is a special case of the wash. A shingled roof will not shed water unless it has a considerable slope. If the slope were too shallow, water would linger on the roof, flow around and under the shingles, and penetrate the gaps beneath. Each type of shingle material has its own recommended minimum slope. A slope steeper than the minimum is advisable on exposed sites where rain is often driven against the building by wind. A good rule of thumb is to avoid roof slopes less than 4:12. Wood shingles, asphalt shingles, and unsoldered metal roofing can go as flat as 3:12 with a special underlayment (consult the appropriate literature from trade associations or manufacturers for more information). Steeper slopes shed water faster and thus are less prone to problems. However, they may be more costly because the roof area is increased, and workers will have greater difficulty moving about the steeper surface. Many roofing materials can be installed at a very steep slope, even on vertical surfaces.

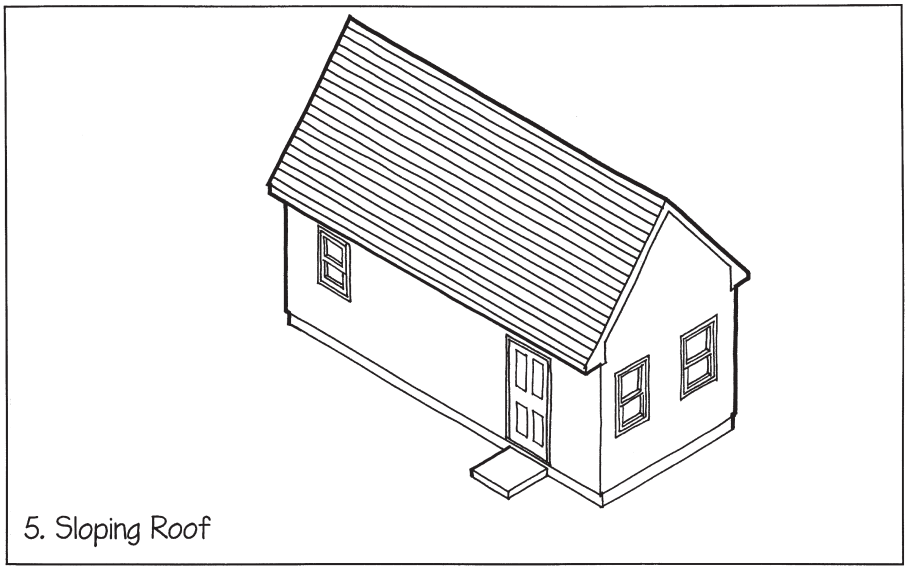
6. So-called flat roofs are seldom flat. They are given a positive slope toward points where water is removed by roof drains or scuppers, because standing water on a roof can cause deterioration of the roof membrane and even structural collapse. The correct name for "flat" roofs, in fact, is "low-slope" roofs. Drains in a low-slope roof should be located either at points of maximum structural deflection (usually the midspan of a beam or joist) or at low points purposely created by sloping the structure that supports the roof.



3. Washes at Parapet



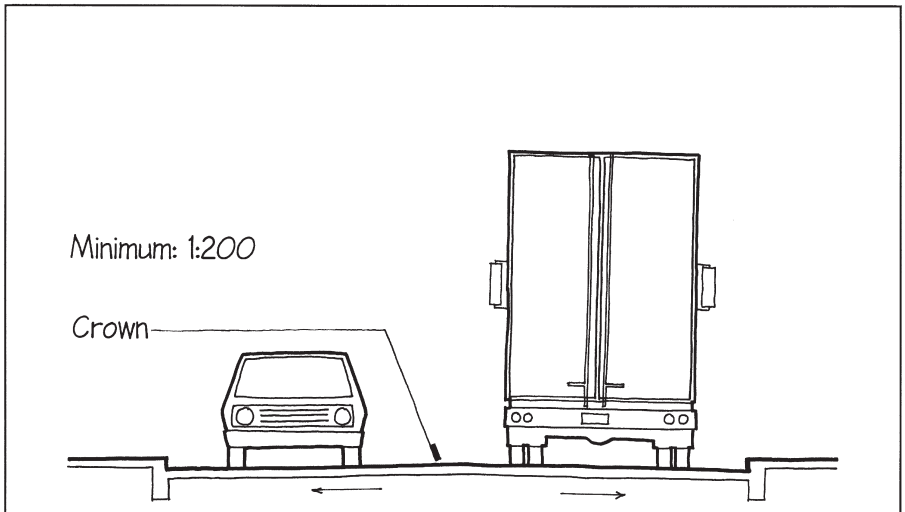
4. Horizontal Panel Joint


5. Sloping Roof

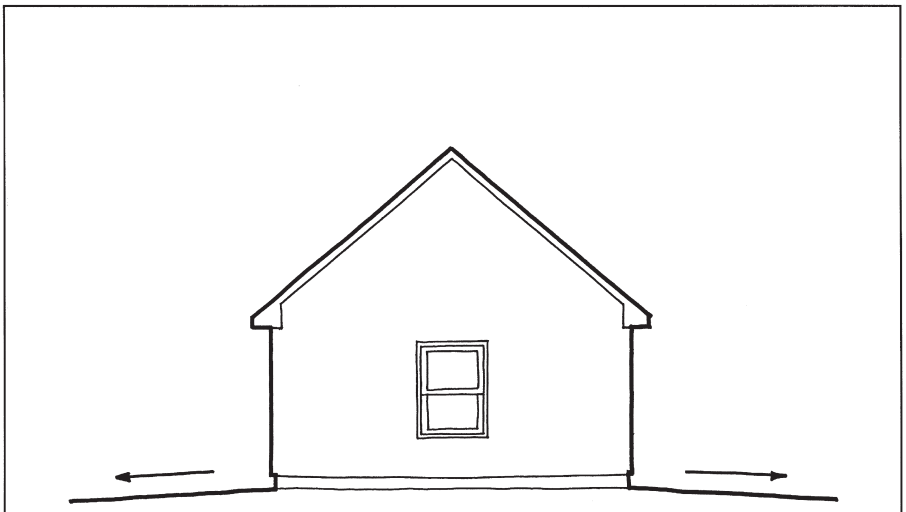
11. Roads, driveways, and walks are usually crowned, to shed water in both directions and to avoid puddling. The slope on each side of the crown should be at least 1:200. Parking lots should slope at least 1:100 to shed water, but not more than 5:100.

12. The ground surrounding a building should slope away from the building at a rate of at least 2:100 for at least 6 ft. (1.83 m). This helps keep water from puddling against the foundation and leaking into basements and crawl spaces.

A wash ensures that gravity will act to keep water away from an opening, but its action can be overcome by strong wind currents. Thus, a wash that is contained within a joint is often combined with an air barrier and a pressure equalization chamber to form a rainscreen joint (see ***Rainscreen Assembly and Pressure Equalization***, later in this chapter). ■



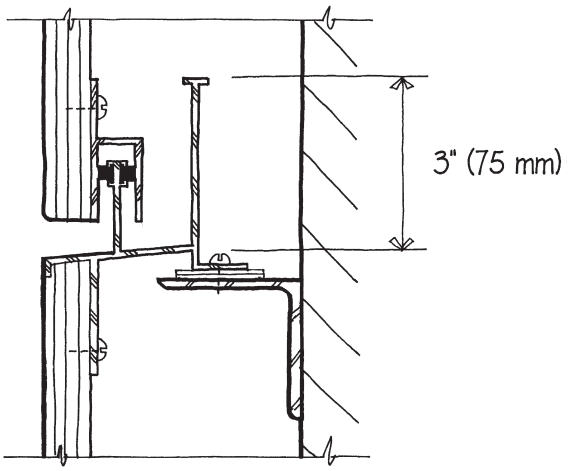
11. Crowned Roadway


12. Slope Away From Building

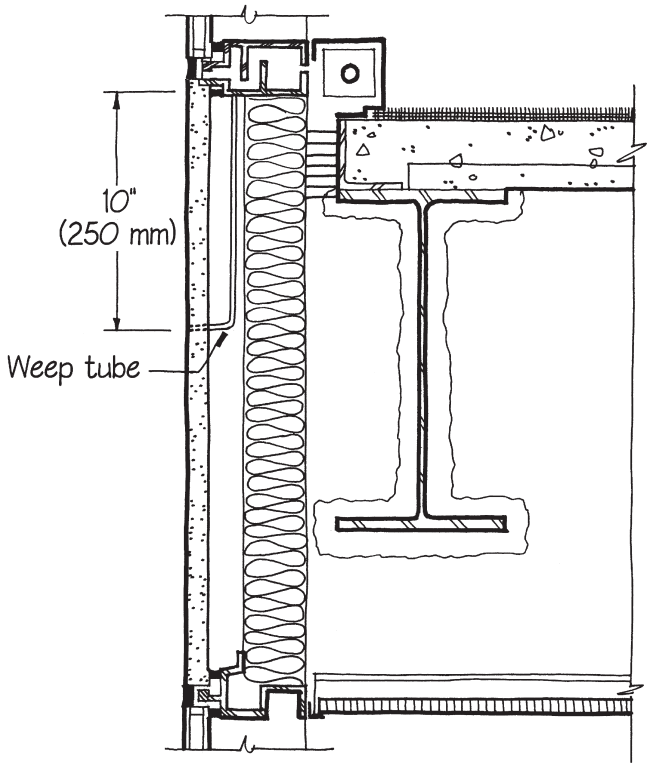
2. This horizontal joint between metal curtain wall panels has a 3 in. (75 mm) upstand, giving protection against water penetration at wind pressures as high as 15 psf (720 Pa), even if the gasket has been inadvertently omitted during installation.

3. To be absolutely safe against water being pumped back through a weep hole by wind pressure, the hole can be drained through a vertical weep tube that exits the wall a distance below the point that is being drained. If there is a vertical distance of 10 in. (254 mm) between the inlet and outlet of a weep tube, for example, it would take a wind of approximately 140 mph (225 km/h) to pump water up and into the building through the tube. This is the principle of the upstand applied in a slightly different manner, using the same table to equate heights of water to pressures of air. The tube diameter must be at least ⅜ in. (9.5 mm) for good drainage; this is also large enough to prevent capillary entry of water.

When detailing an upstand, remember that its ends must be dammed carefully at vertical joints, or the water will simply drain out of the ends to become unwanted leakage. In aluminum cladding details, end dams are often plugs molded of synthetic rubber. ■



2. Horizontal Joint Between Curtain Wall Panels



3. Weep Tube in Curtain Wall

Sealant Joints and Gaskets

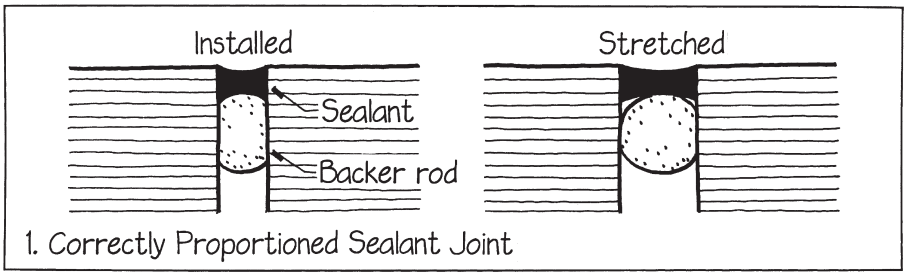
Sealants and gaskets are elastic materials that can be placed in a joint to block the passage of air and/or water, while allowing for relative movement between the two sides of the joint. A gasket is a strip of elastomeric rubber that is compressed into the joint. Most sealants are mastic materials that are injected into the joint and then cure to a rubberlike state. A gasket seals a surface by compressing tightly against it. A sealant seals by adhering tightly to the surface.

1. The width and depth of a sealant joint must never be left to chance; they should be determined in accordance with the procedure shown in ***Expansion Joint*** (see Chapter 6). The plastic-foam backer rod is a very important part of every sealant joint: It limits the depth of the sealant to the predetermined dimension, provides a firm surface against which to tool the sealant, and imparts to the sealant bead the 1:2 hourglass shape that optimizes the strength and elasticity of the sealant. The backer rod should be at least 20 percent larger than the maximum joint width.

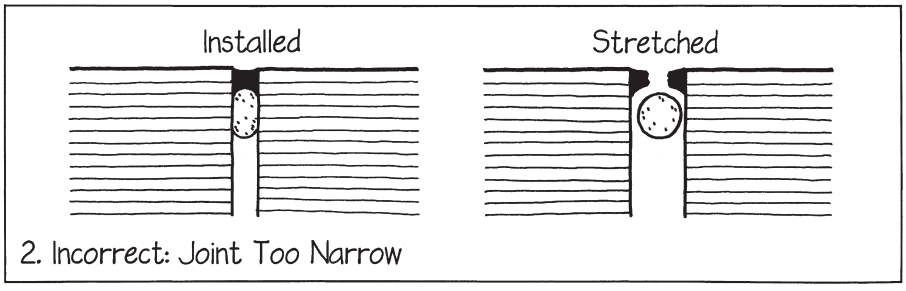
2. If the sealant joint is too narrow, normal amounts of movement between the adjoining components can overstretch the sealant and tear it. This can also happen if the sealant joint is too shallow in proportion to its width.

3. If the sealant bead is too deep, stresses in the bead will be excessive, and tearing is likely.

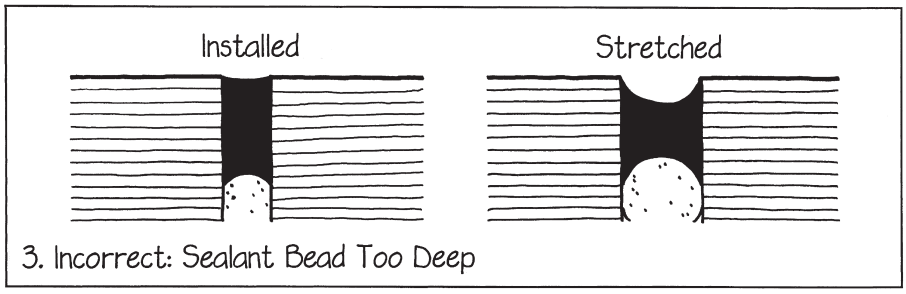
4. Tooling forces the sealant material to fill the joint, assume the desired profile, and adhere to the adjoining components.



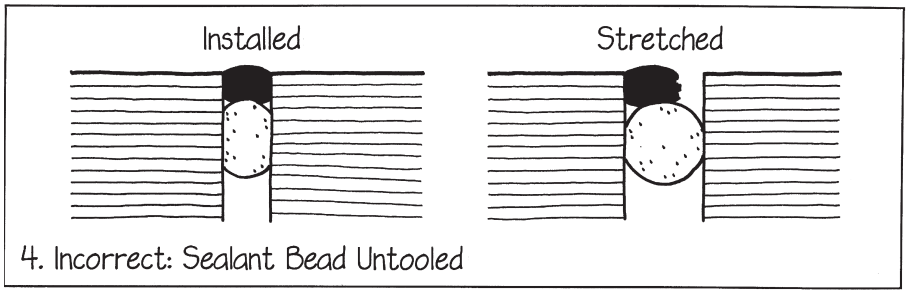
1. Correctly Proportioned Sealant Joint



2. Incorrect: Joint Too Narrow



3. Incorrect: Sealant Bead Too Deep

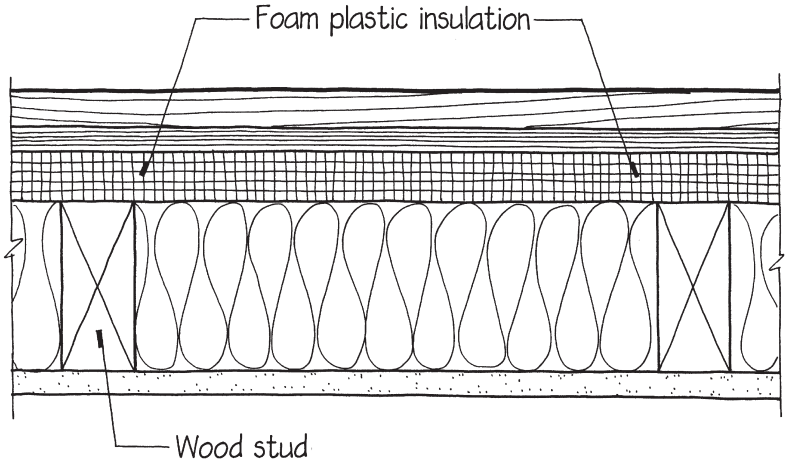


4. Incorrect: Sealant Bead Untooled

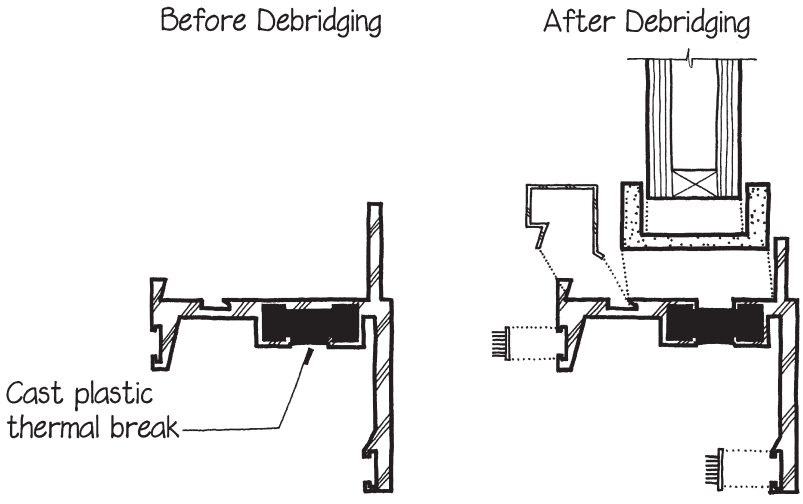
2. Although wood is not highly conductive of heat (as compared to metals), wood studs and rafters do conduct heat much more rapidly than the insulated cavities between them. Approximately 15 percent of the area of a light frame wall is wood framing, not insulated cavity. In some energy-efficient buildings, a continuous plane of rigid plastic foam insulation is added across either the outside or the inside of the framing members as a thermal break. In addition to providing thermal breaks over each framing member, this also increases the assembly's overall thermal resistance.

3. Aluminum conducts heat even more readily than steel. This can be a problem in aluminum window frames, door frames, and cladding components, in cold climates. Where aluminum passes continuously from outdoors to indoors in these components, large quantities of water and frost often condense on the cold inner surface in winter. To prevent this from happening, several types of thermal breaks have been developed for use in aluminum members. In the example shown here, a hard plastic is cast into a groove in the aluminum member during manufacture. Then the groove is debridged (the thermal bridge is removed) by milling away the aluminum at the bottom of the groove. This leaves only the low-conductivity plastic thermal break to connect the indoor side of the member to the outdoor side.

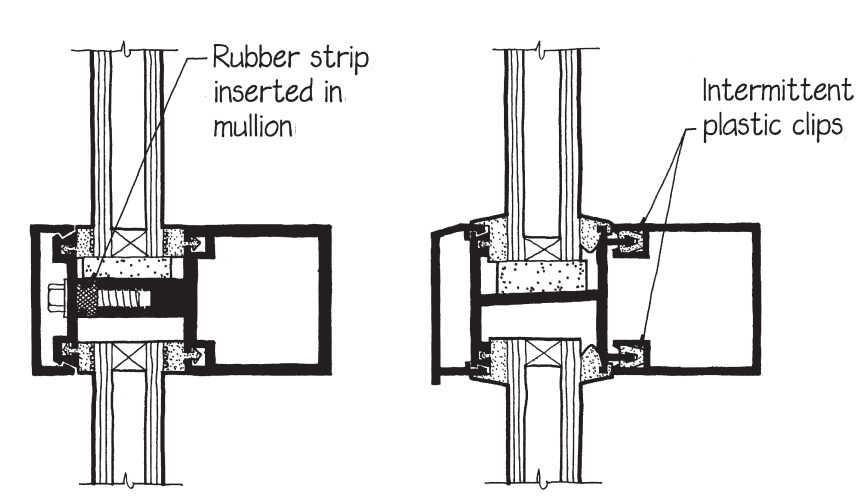
4. A second type of thermal break for an aluminum cladding assembly is a simple plastic or rubber strip that is inserted between the outer and inner layers of a mullion during assembly. The aluminum screws remain as thermal bridges, but they are too small in area to conduct much heat. A third type of thermal break for an aluminum assembly is the use of small, intermittent plastic clips that mount the interior cover components to the mullion. ▷



2. Foam Plastic Insulation Across Wood Studs



3. Thermal Break in Aluminum Window Frame

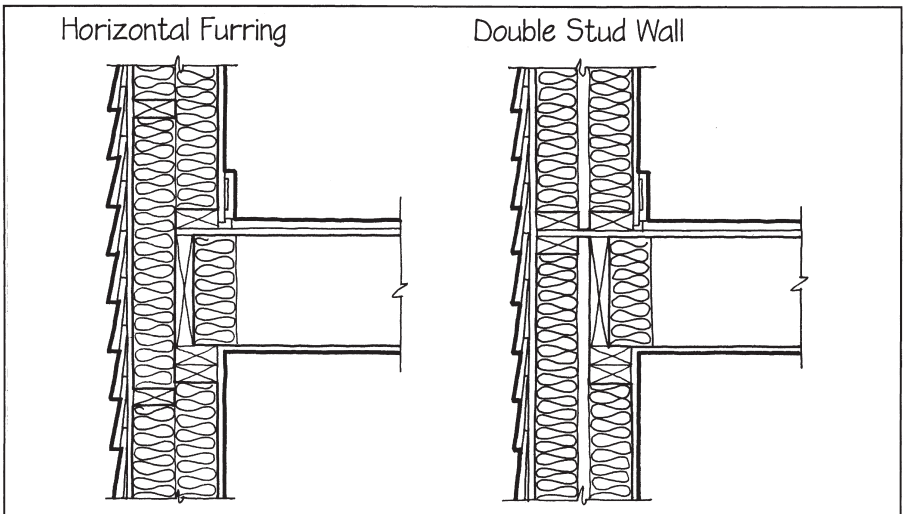


4. Thermal Breaks in Aluminum Cladding Systems

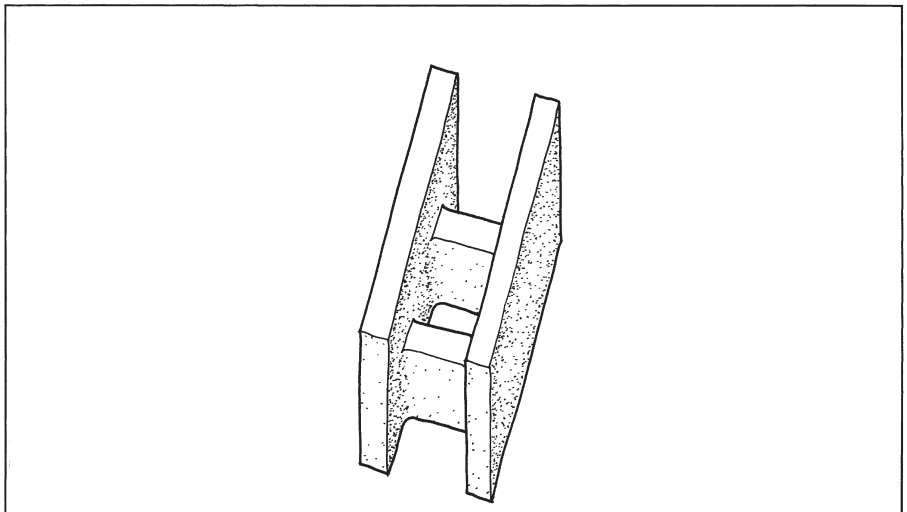
5. If greater thermal insulation in a wood light frame wall is required, then other insulation and framing strategies can be used. One is to apply horizontal furring strips and a second layer of insulating batts across the outside or inside face of the studs. Another is to construct another stud wall just outside the first, leaving a small airspace between the studs to act as a thermal break. The first method reduces the thermal bridging caused by wood framing to only about 4 percent of the wall area. The second method can lower the bridging area to less than 1 percent.

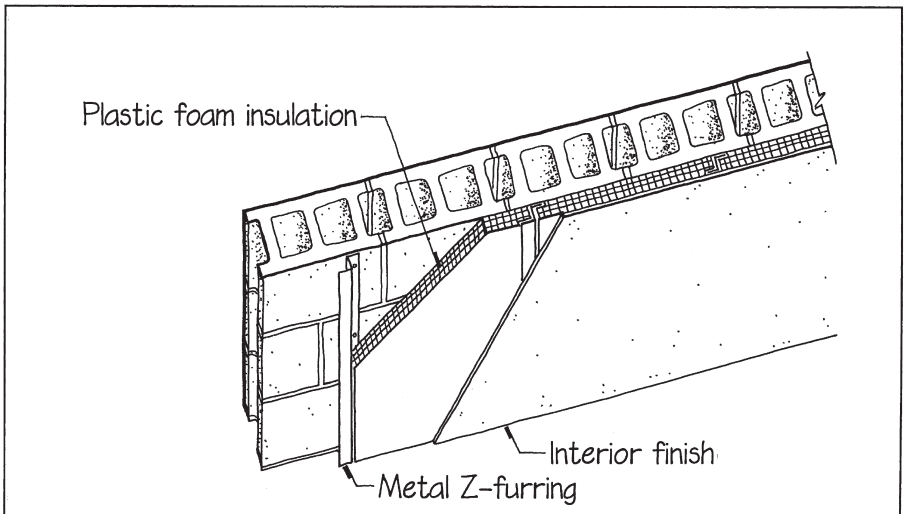
6. Hollow concrete masonry units can be insulated by filling their cores with either a granular fill insulation or plastic foam inserts, but the webs of the units act as thermal bridges. Many different schemes have been invented to minimize these bridges. Several kinds of proprietary masonry units have been designed with webs that are as small in cross section as is structurally feasible, to reduce the thermal bridging effect.

7. A generic approach to the thermal bridging problem in concrete masonry is to furr the masonry wall on the inside and to insulate between the furring strips. This method can also be used on concrete walls. Placing insulation inside of the masonry or concrete wall nullifies the value of the thermal mass of those materials; see ***Outside-Insulated Thermal Mass***, later in this chapter, for a complete discussion.



5. Thermally Broken Wood Stud Walls


6. Concrete Masonry Unit With Minimal Webs



7. Inside Furring and Insulation on Concrete Masonry Wall

Quiet Attachments

Squeaks, bangs, rumbles, and other structural and mechanical noises in buildings can be reduced or prevented by careful detailing and proper maintenance.

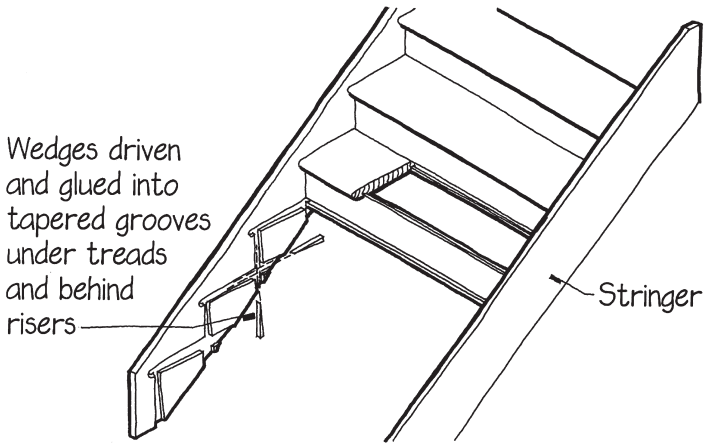
1. A wood subfloor that is glued to the supporting joists as well as nailed is much less likely to loosen and squeak over time than a subfloor that is merely nailed. Screws or ring-shank nails are much less likely to loosen and squeak in a subfloor than common nails.

2. A prefabricated wood stair with housed stringers uses wedges and glue to create a tight unit that is highly resistant to loosening and creaking underfoot.

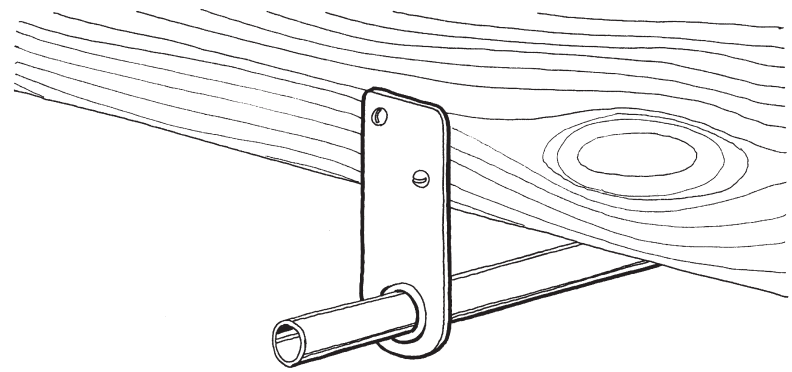
3. Doorstops, frame pads, and door closers reduce dramatically the amount of noise that a door can generate as it opens and closes.

4. Motors, pumps, fans, and other machinery should be isolated acoustically from the structure of the building to reduce the transmission of structure-borne noise. Many types of resilient equipment mounts are available that use metal springs or rubber pads to isolate equipment vibrations from the structure. Flexible duct connectors should be used to join ductwork to fans.

5. Hot water pipes and hydronic heating pipes expand and contract longitudinally when they heat and cool. This causes them to rub against their mounting brackets. A smooth plastic mounting bracket reduces friction against the pipe and virtually eliminates the ticking and scraping noises that a metal bracket would generate. ■



2. Prefabricated Wood Stair with Housed Stringers



5. Plastic Bracket for Hydronic Piping



Sound-Absorbing Surfaces

Soft, porous, thick finish materials absorb most airborne sound and reflect little. This makes them useful in achieving quiet conditions inside a building.

1. The accompanying table indicates the capacity of various surfaces to absorb airborne sound. The Sound Absorption Coefficient [which supersedes the Noise Reduction Coefficient (NRC)] indicates the average amount of sound energy absorbed by a material in the normal audible range. A coefficient of 0.0 indicates that the material is a perfect reflector of sound; 1.0 indicates that it is a perfect absorber. A material with a coefficient of 0.80 absorbs 80 percent of the noise incident upon it.

2. A carpet and pad, upholstered furniture, and window draperies all absorb sound and are effective in reducing sound levels within a room. Unpadded carpet and thin upholstery and curtains absorb only very high frequencies of sound, however, leaving noise at middle and low frequencies as a continuing problem.

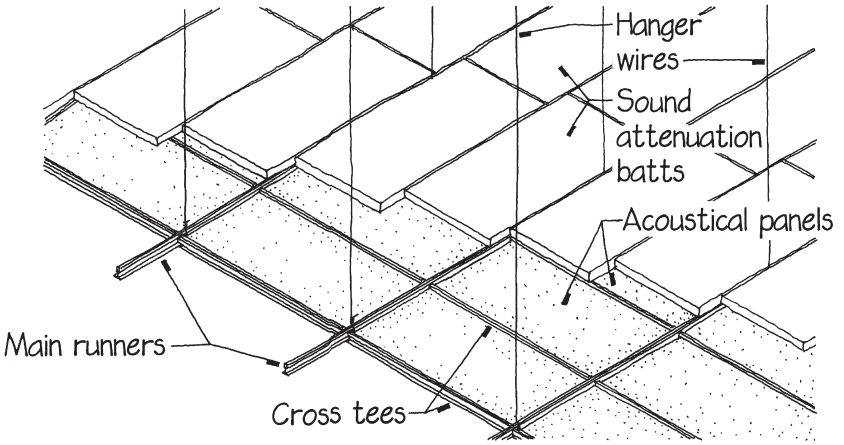
TABLE 5-4 Approximate Sound Absorption Coefficients of Common Materials

(Values measured across a frequency range of 250—2000 Hz)	**Sound Absorption Coefficient**
Brick, unpainted	0.03–0.05
Brick, painted	0.01–0.02
Concrete, rough, unpainted	0.02–0.08
Concrete, smooth, painted	0.01–0.02
Concrete masonry unit, unpainted	0.29–0.44
Concrete masonry unit, painted	0.05–0.10
Cellulose fibers, sprayed	0.50–0.75
Polyurethane foam, rigid insulation board	0.30
Polyurethane foam, profiled acoustic panel	0.80
Carpet, on foam rubber pad	0.30–0.55
Wood tongue-and-groove floor	0.08–0.19
Plywood	0.10–0.18
Wood, perforated acoustic panel	0.75–0.90
Wood, perforated acoustic panel, with acoustic fiber in void	0.70–0.95
Mineral fiber acoustic ceiling panels, suspended, high noise reduction	0.75–0.90
Glass	0.02–0.10
Steel	0.01–0.10
Metal, perforated sheets, 13% open	0.64–0.97
Plaster or gypsum board, painted	0.01–0.05
Marble or glazed tile	0.01–0.02
Wood or metal seating (occupied)	0.80–0.85
Wood or metal seating (unoccupied)	0.30
Fabric upholstered seating (unoccupied)	0.60
Fabric curtains, varying weight	0.05–0.60
Water or ice	0.01–0.02

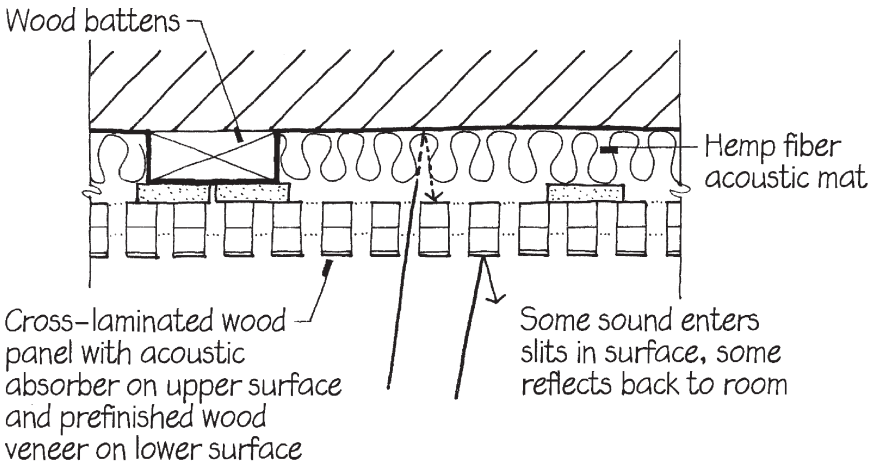
3. Ceiling-mounted acoustical tiles and panels are manufactured in a wide range of noise reduction coefficients. Full ceilings of highly absorbent panels or tiles are useful in quieting noisy office or retail spaces. The ability of an acoustical ceiling to absorb lower frequencies of sound can be enhanced by suspending it or furring it down from the structure above, and by installing sound attenuation batts on top of it. Acoustic plaster, even if properly installed, is an effective absorber only at higher frequencies.

4. Hard, acoustically reflective ceilings of wood, plaster, gypsum board, or prefabricated panels are appropriate in many types of spaces designed for good hearing of speech or music. Such spaces should be designed in collaboration with an acoustical consultant.

5. Proprietary acoustic panels made of fabric, perforated gypsum, or perforated wood can be selected to alter the sound absorption qualities of ceilings and walls. Manufacturers also provide acoustic design tools to aid the detailer in making appropriate selections for each surface of a room. For instance, a perforated cross-laminated wood panel may be chosen for a wall or ceiling surface to reflect voices in the room, but absorb other frequencies. The perforations permit sound to pass through the surface to be absorbed by acoustically absorptive materials that are installed between furring strips. Other room surfaces may have similar wood panels that are grooved on the face but not perforated, and others that are smooth, each of which will reflect sound back into the room differently. ■



3. Suspended Acoustical Ceiling Seen from Above



5. Acoustic Ceiling Assembly

Relieved Back

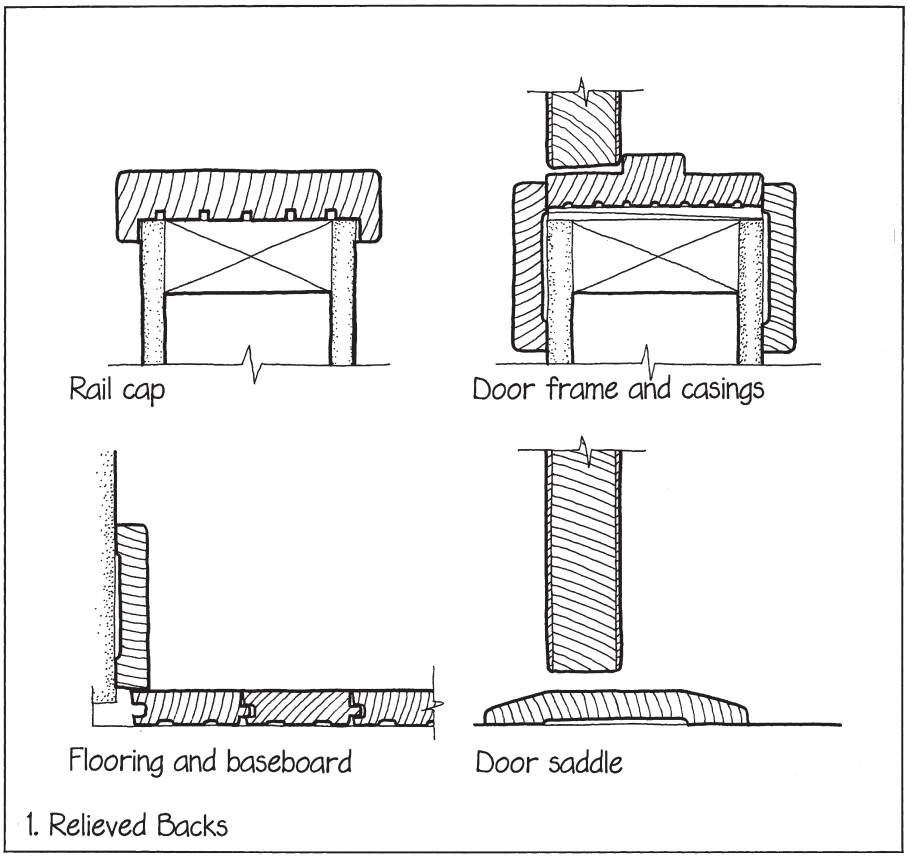
Problems caused by cupping distortions in flat finish pieces of wood can be minimized by using a profile with a relieved back and by back priming each piece.

Cupping distortion is most evident in wide boards, especially if their grain is not straight and vertical (see ***Vertical-Grain Lumber***, earlier in this chapter). Similarly sized manufactured wood products, such as medium-density fiberboard (MDF) and composites made of wood and resin, tend to be free of internal stresses that might cause cupping, but still may change in shape if not uniform in moisture content.

1. Cupping distortion of a wood board is caused by a difference in the amount of shrinkage experienced by the opposite sides of the board. The thinner the board, the less the force that can be exerted on it by this difference in shrinkage. It is common practice to relieve the backs of flat pieces of wood millwork by cutting one or more grooves, thus effectively reducing the thickness of the pieces and diminishing their tendency to cup. If a single, wide groove is cut, it also makes the piece easier to attach to a flat surface, because only the two edges need to touch.

In factory-produced millwork, the grooves are usually cut by shaping machinery. On the jobsite, it is usually more practical to cut multiple grooves on a portable table saw.

2. Back priming, the application of a coat of primer paint to the back side of a board, is also helpful in preventing cupping distortion of flat pieces of wood that will be painted. Siding boards, corner boards, exterior trim pieces, casings, and baseboards can all benefit from back priming.



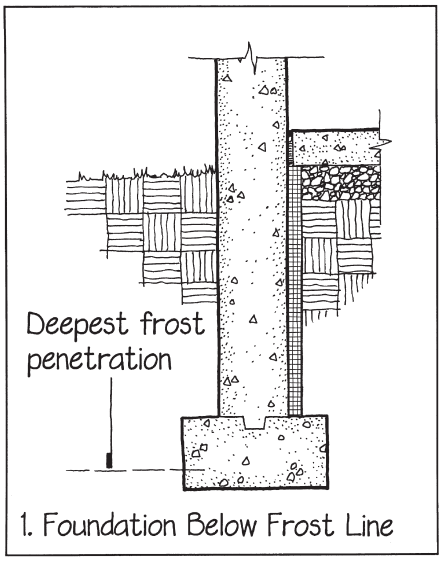
1. Relieved Backs

The effect of back priming is to cause both the front and back surfaces of the board to react to moisture at roughly the same rate. The back priming needs to be done at least a day in advance of installation, to give the primer time to dry. It should be noted in the millwork section of the specifications for the building and specified in detail under the painting section.

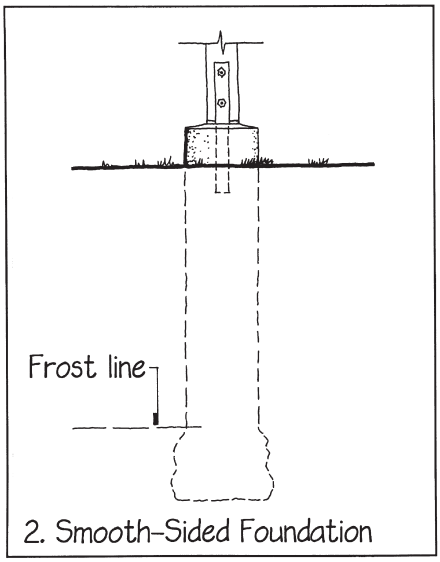
3. Closely related in principle to back priming is the practice of back facing a door or shelf that is surfaced with plastic laminate. The back facing prevents warping caused by unequal absorption of moisture by the two sides of the panel. Where it will not show, the back facing is usually made of a plain, low-cost laminate. Although it is virtually a necessity on shelves and doors, back facing is usually not required on surfaces that are tightly connected together in boxed assemblies, such as countertops and cabinet frames, because the bracing action of the box prevents severe warping. ■

1 Foundation below Frost Line

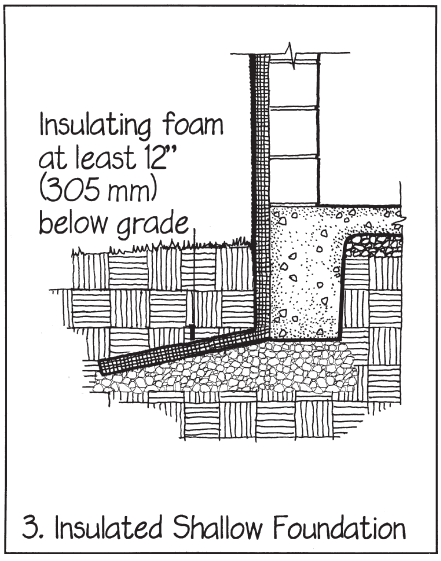
One type of building movement that we can prevent is frost heaving. Frost heaving is caused by water freezing in the soil beneath a building's foundations. Phase-change expansion of the water can cause the soil to expand up to 9 percent, lifting the building slightly. Under certain temperature and moisture conditions, larger amounts of lifting can occur as a result of the growth of long vertical crystals of ice under the foundation. It is impossible to eliminate groundwater, so we place foundations on soils that will not freeze.



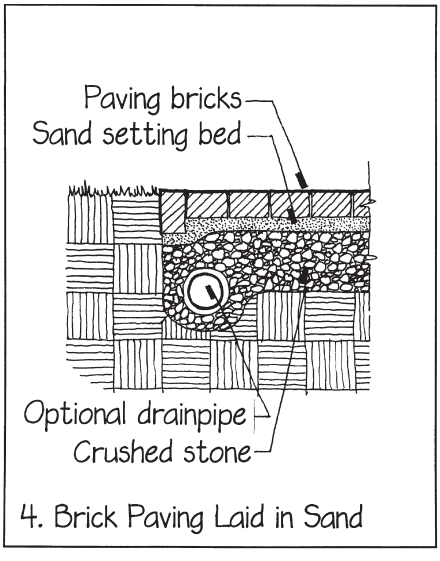
1. Foundation Below Frost Line



2. Smooth-Sided Foundation



3. Insulated Shallow Foundation



4. Brick Paving Laid in Sand

1. Building codes generally require that the bottom of a foundation be placed at a level below the deepest level to which the ground freezes during a severe winter; consult the applicable building code for the location to find out how deep this is. Exceptions to this general pattern are made only when there is no water below the foundation, such as when one is building upon solid rock, or upon permafrost, both of which are very rare situations. In locations not subject to freezing temperatures, building codes require that foundations must simply be at least 12 in. (305 mm) below finish grade.

2. Isolated pier foundations are economical and effective for decks, porches, and small wooden structures. A post hole digger is used to excavate for each pier. The concrete should not be cast directly against the rough sides of the hole, however, because frost can heave upward against the rough sides of the pier. A smooth fiber tube form should be used to cast piers whose sides are smooth above the frost line. Similarly, a foundation wall should be cast in smooth forms, not directly against the walls of the trench.

3. The International Code Council (ICC) now allows an innovative shallow foundation strategy that has been used successfully in cold northern European climates for decades. The frost-protected shallow foundation (FPSF) system uses an exterior layer of plastic foam insulation to contain heat that escapes from the building interior, to warm the soil beneath the foundation and keep it from freezing.

This detail should not be used for an unheated building, such as a barn or storage building, or for a building subject to interruption of its heating system in winter months. It is also not recommended where termites are found, because they tend to burrow in the insulation. Building codes for relevant localities set forth minimum foundation depths and insulation requirements.

4. It is not practical to support outdoor pavings such as roads, patios, and walks, on foundations that go below the frost line; they must be supported at a much shallower level. Most frost heaving can be prevented, however, by placing the paving (concrete, asphalt, brick, or stone) on a thick, *well-drained* layer of crushed stone that is graded (sorted) so that it has no fine particles. The spaces between the stones drain water away from the underside of the paving and also furnish expansion space for water that freezes in the soil below. For brick and stone pavings, a sand setting bed above the crushed stone gives the mason a precise means of regulating the height of the masonry units.

The many small gaps in traditional mortarless, dry-stacked stone walls have a similar capacity to drain water and accommodate minor movement without cracking. ■

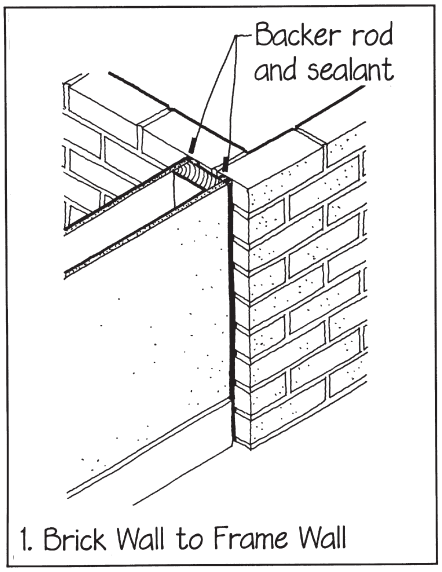
Abutment Joint

Abutment joints allow for movement between dissimilar materials or between old and new construction. Dissimilar materials tend to move at different rates and in different patterns. Old construction has already undergone foundation settlement, long-term structural movements, and initial moisture movements, while new construction has not. In either case, an abutment joint should be provided to allow for differential movement between the two parts of the construction.

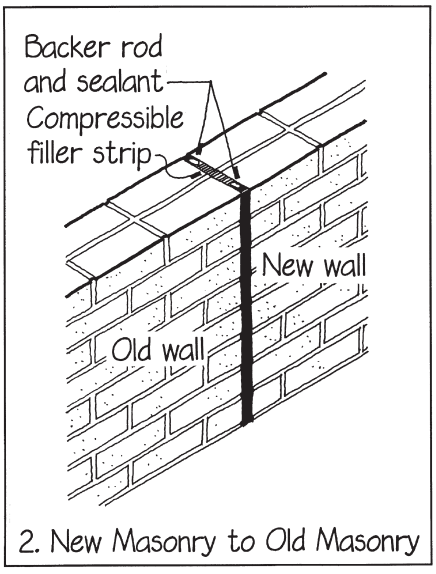
1. This drawing shows an abutment joint between a masonry wall and a wood-frame wall. A small space separates the wood frame from the masonry, and a sealant joint of generous width allows for differential movement.

2. New and old masonry should not be interleaved, but should be separated cleanly and connected by a flexible abutment joint. This is easier for masons to lay and avoids the cracking that might be caused by the shrinkage of the new mortar. For compositional considerations related to abutting materials in the same plane, see ***Formal Transitions***, Chapter 14.

The same principles apply to the joints between new and old concrete assemblies. ■



1. Brick Wall to Frame Wall



2. New Masonry to Old Masonry

CHAPTER 10

Providing for the Aging of the Building

WHEN WE DESIGN and build a building, we hope that it will last a very long time. Most buildings do. But as the months and years go by, every building changes. Its surfaces wear, weather, and gather dirt. They undergo chemical changes such as fading and corrosion. Components of the building fail and are replaced. The building is remodeled or renovated from time to time. Often a beautiful building grows less so as these changes take place. Another building may grow more beautiful and take on added character as changes take place. Some buildings last only a short time; others last for centuries. There are many reasons for these differences. Most have to do with materials and detailing.

Many of the detail patterns throughout this book have a profound effect on the rapidity with which a particular building ages, but there are three categories of detail patterns that relate specifically to managing the life cycle of a building. Each of these detail patterns will be listed below and described more fully later in this chapter.

The first category contains patterns about designing a building with a perspective toward its entire lifetime:

Life Cycle (p. 146)
Expected Life (p. 148)
Surfaces That Age Gracefully (p. 150)

The second category relates to the need to maintain a building:

Repairable Surfaces (p. 152)
Cleanable Surfaces (p. 153)
Maintenance Access (p. 154)

The third category includes six patterns that have to do with building deterioration:

Dry Wood (p. 156)
Protected and Similar Metals (p. 158)
Less Absorbent Materials (p. 161)
Robust Assemblies (p. 163)
Building Armor (p. 164)
Extreme Event Protection (p. 166)



Life Cycle

Architects understandably focus chiefly on the initial conditions of the building. We must also consider the impact on conditions "upstream" and "downstream" of the building itself. Building materials come from someplace, they are used in the building, and then they go someplace else. The building's distant and long-term impacts on the environment must be considered if advances in building design and construction are to be sustainable.

1. Construction by its nature transforms raw natural materials into useful building elements, each of which has its own life cycle. At varying rates, these materials expire physically, or they become functionally obsolete as improved products become available.

2. Owners and regulatory bodies may require that specific environmental impact objectives be met in order for a project to be built. Life Cycle Assessment (LCA) addresses the qualitative influences, and Life Cycle Cost (LCC) analyses address the economic implications. No single aspect of LCA dominates all others, but a given project may give priority to one aspect over others. The detailer should look creatively at various options to find the strategy most appropriate for a particular project. Many digital LCA and LCC modeling tools are available to examine options and document results. Technical references and rating systems are also available to aid in this process.

LIFE CYCLE OF A BUILDING MATERIAL

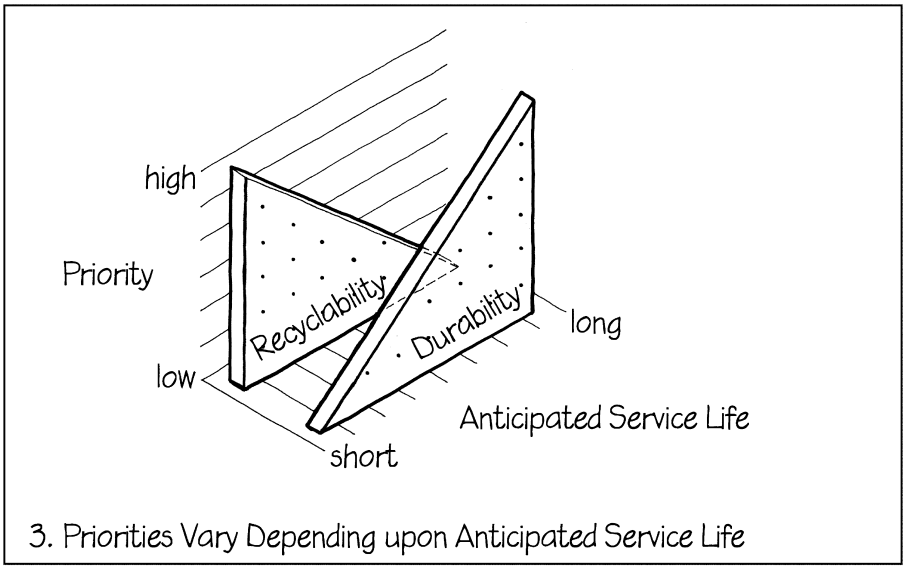
(with associated environmental impact at each stage)

1. Source of material; *Impact*: Extraction of renewable or nonrenewable material from nature, material recycled from previous use, or some combination
2. Transport of material to site; *Impact*: Means, distance, and type of fuel
3. Industrial processes: refinement of raw material, fabrication of finished product; *Impact:* Energy types and quantities consumed, generation of by-products
4. Construction processes and maintenance or repair during service life; *Impact*: Energy types and quantities consumed, generation of by-products
5. Building operation; *Impact*: Energy types and quantities consumed for illumination, heating, and cooling; influence of materials on indoor air quality; impact on outdoor air and water quality, etc.
6. Deconstruction or demolition; *Impact*: Energy types and quantities consumed, generation of by-products
7. Reuse of serviceable components and recycling of salvageable materials; *Impact*: Energy types and quantities consumed, generation of by-products
8. Disposal of waste; *Impact*: Air and water quality impact, transport means, distance and type of fuel

3. The priorities for some building elements may be different from others because of differences in their service lives. For instance, use of recyclable materials is a higher priority for carpet and roofing membranes that must be replaced periodically during the life of the building. Durability is the highest priority when designing the foundation and primary structural system of a building. Recyclability is of greatest concern when the service life of the element is short, and it is less important when the service life is very long.

4. Renewable resources such as wood should be used at rates lower than the rate at which they are replenished by nature.

5. Nonrenewable resources should be used efficiently and durably, and they should be reused or recycled at the end of the service life.



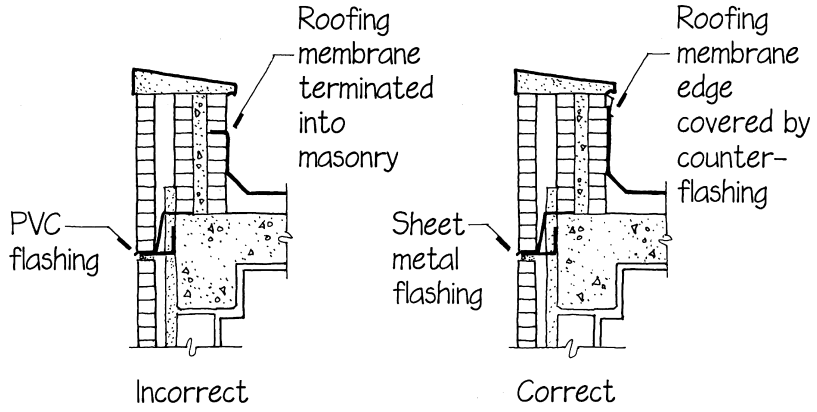
3. Priorities Vary Depending upon Anticipated Service Life

6. Many manufacturers offer information about the origins of their products, making it easier for designers to choose low-impact products. Labels on materials and certificates of authenticity document the claims. The increasing use of the international Environmental Product Declarations (EPDs) that are based upon accepted Product Category Rules (PCRs) provide designers with a robust factual indication of a material's initial environmental impact. Accessibility to objective environmental data regarding materials and processes empowers detailers to make informed decisions.

7. Embodied energy is the energy needed to extract, refine, process, transport, install, and reuse or dispose of a material. It is very difficult to measure, but generally materials that (1) require a great deal of energy to extract or manufacture, (2) are transported a great distance, or (3) require greater maintenance while in service will have the highest embodied energy. Materials of local origin that are not energy intensive in their manufacturing process will likely have the lowest embodied energy. Embodied energy constitutes only about 2 percent of all energy consumed in the life of the building, a tiny fraction compared to the energy used to operate the building. Despite this, it is an important constituent of LCA and LCC analyses, because energy use often correlates with harmful carbon dioxide and pollutant emissions, and of course with costs. ■

4. To lower initial construction costs, elements of a detail are sometimes eliminated, or less durable alternative elements are chosen, often with disastrous results. Many expensive recladding projects are the result of hastily made cost-trimming decisions that save less than 1 percent of the eventually needed repair costs. Lower-quality execution during initial construction often results in higher maintenance costs or shorter service life. Detailers are well informed regarding trade-offs and should play a central role in making optimum choices regarding substitutions of materials and details.

5. Just as we have an operating manual for our automobile, architects may offer to provide building owners with a guide summarizing the maintenance and replacement cycles anticipated for each tier of the building systems. Owners and maintenance staff are collaborators in determining the building's life span; maintenance procedures need to be followed if the predicted service life is to be realized.



6. Anticipating Service Life--Two Versions

6. Details for all building elements should be designed to be accessible in proportion to their longevity. Building elements that are to be replaced at the most frequent intervals, such as lighting tubes and air filters, should be detailed to make routine maintenance easy. Low-slope roof membranes should be detailed so that the membrane can be replaced without requiring that the parapet be reconstructed. Furnaces and boilers are not replaced frequently, but when they are replaced, the bulky, heavy equipment must be accessed without removing walls or other durable assemblies. ■

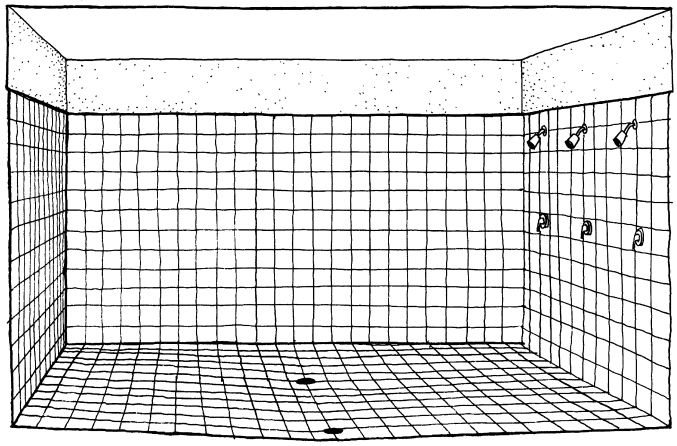
3. Most contemporary wainscoting is a form of armor. It may be made of vinyl wallcovering, tile, concrete masonry, or stone. Often its purpose is to make the wall tough and washable in the zone where it will be rubbed against, poked, kicked, and run into. Sometimes it is intended to make the wall water-resistant in wet areas of a building.

4. Hospitals and nursing homes use corner guards and wall guards to armor walls against wheelchairs, gurneys, pushcarts, and cleaning equipment.

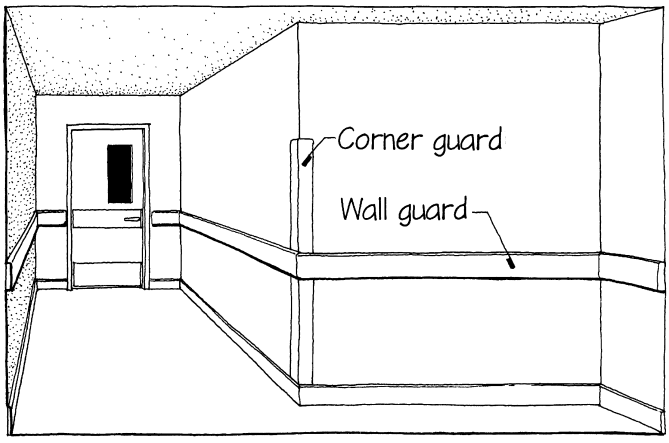
5. Outdoor forms of building armor include curbs and bollards to confine vehicles to roads and drives, and corner guards, protective posts, and dock bumpers where vehicles are allowed to come close to the building.

6. It is best to avoid superficial colors and finishes in high-traffic areas where surfaces are likely to be damaged. Wear and chipped surfaces will reveal inner colors or textures that are different from those on the outside, making the blemish all the more apparent. Sand-finished brick, surface-pigmented concrete, and EIFS are all materials that are superficially coated; they should be avoided in high-traffic areas.

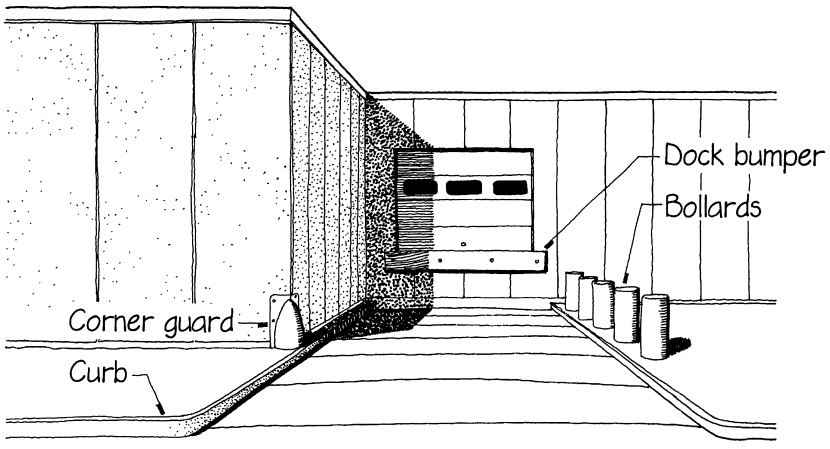
7. Skateboards and roller blades can damage outdoor stairs, walls, and landscape features, unless surfaces are made unsuitable for damaging activities. Durable elements can be embedded into construction materials or secured to surfaces to discourage abuse. The edges most susceptible to abuse can be detailed with integral ribs, grooves, ridges, or premanufactured guards to eliminate long, continuous slides. ■



3. Tile Wainscot in Shower Room



4. Corner Guards and Wall Guards

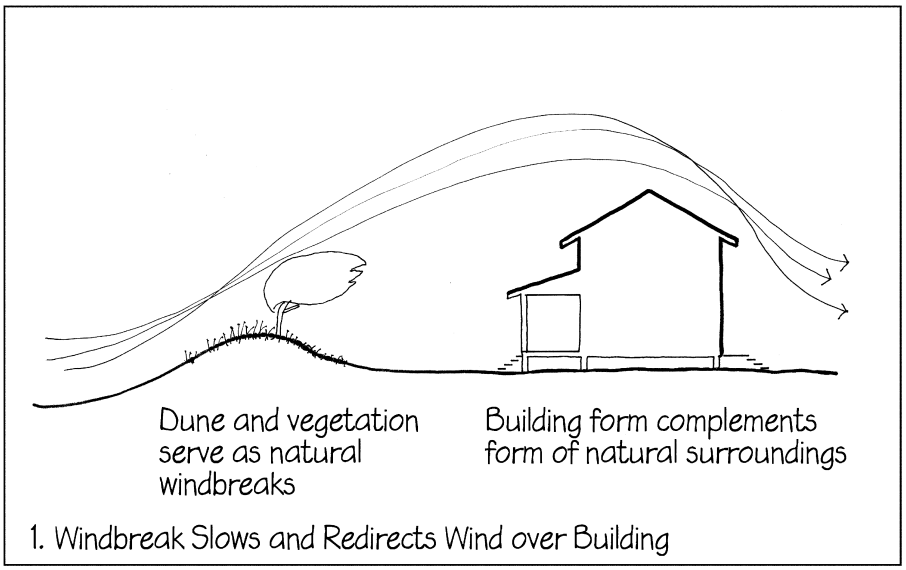


5. Outdoor Armor

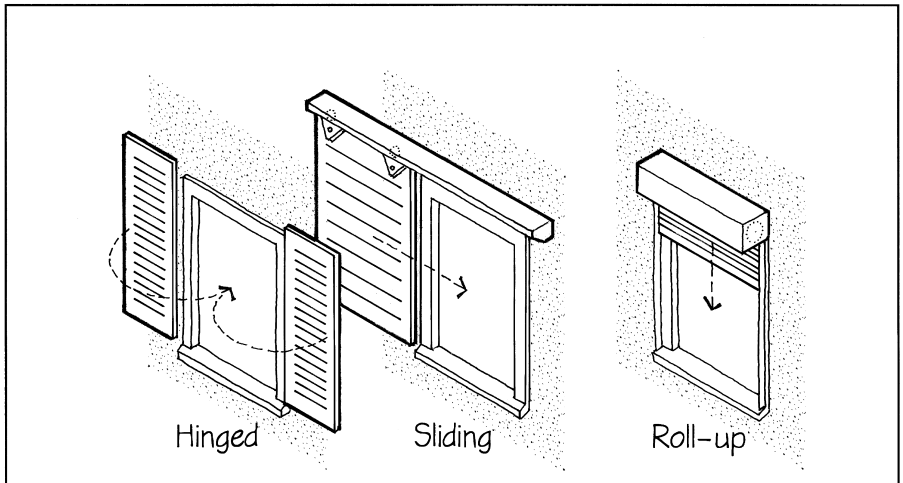
Extreme Event Protection

Building massing, surfaces, and details are often shaped by the unusual conditions that occur infrequently, perhaps only a few times during the service life of the building. Of course, building designers address the ordinary conditions, but they must also make buildings that have a chance of surviving extraordinary but plausible conditions. The best way to avoid damage due to extreme events is to build far away from them. However, many building locations are subject to some threat of at least one extreme event, so designers must try to prepare for them.

Many extreme events are so rare that it would be impractical to direct resources toward them. It also should not be expected that buildings would be designed to resist natural or man-made events whose destructive forces are so extreme that preventative measures would be unreasonable or would disproportionately skew the qualities of the building away from its normative needs. However, for a given location, threats of winter storms, hurricane-force winds and rain, and storm flooding can be reasonably estimated on the basis of past history. Building designs in such settings should strive to meet expected challenges.



1. Windbreak Slows and Redirects Wind over Building



2. Shutters Protect Vulnerable Window Materials

1. Wind can damage buildings directly but can also damage buildings indirectly through airborne debris. Several detail design strategies can help mitigate extreme wind forces and protect vulnerable parts of a building.

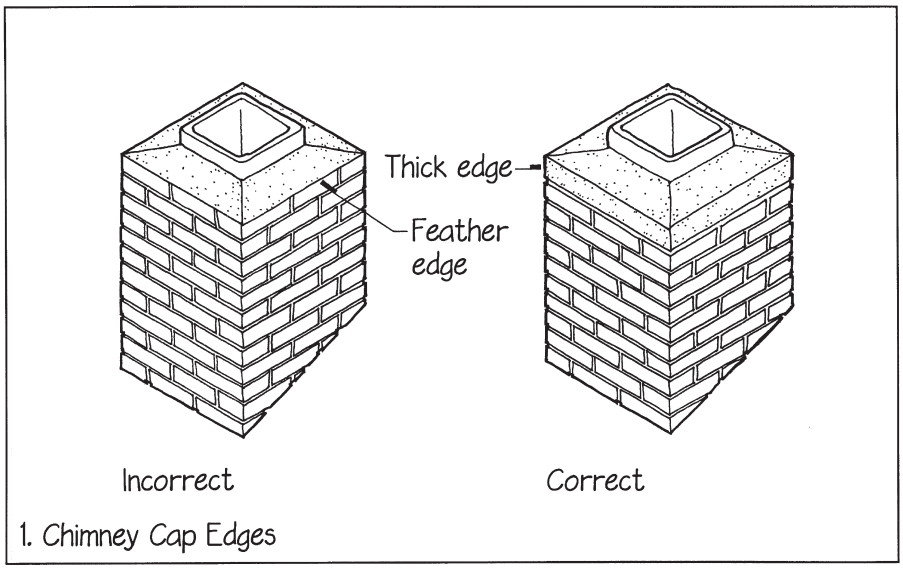
Windbreaks that are located upwind from the building can direct the main current of air over and around the building, and can slow the air that passes through the windbreak. Windbreaks can be either natural or constructed. Natural elements that can serve as a windbreak include dense vegetation, such as trees and shrubs, or earth dunes, mounds, or berms. Constructed elements could include walls, fences, or screens. For maximum effectiveness, windbreaks can be configured in coordination with a building's roof or wall shapes to deflect air over or around the building.

2. Brittle exterior glazing is particularly vulnerable to airborne debris carried by high winds. Broken windows can lead to pressurization of building interiors, which can cause other portions of the building envelope, such as sheathing, to come loose. Traditional methods of window protection, such as shutters, have been used for centuries to protect glazing from wind and airborne debris. Contemporary solutions to accomplish this include louvers, sliding panels, roll-up shutters, or other more complex elements. The basic strategy is to temporarily shield a vulnerable material with a stronger material.

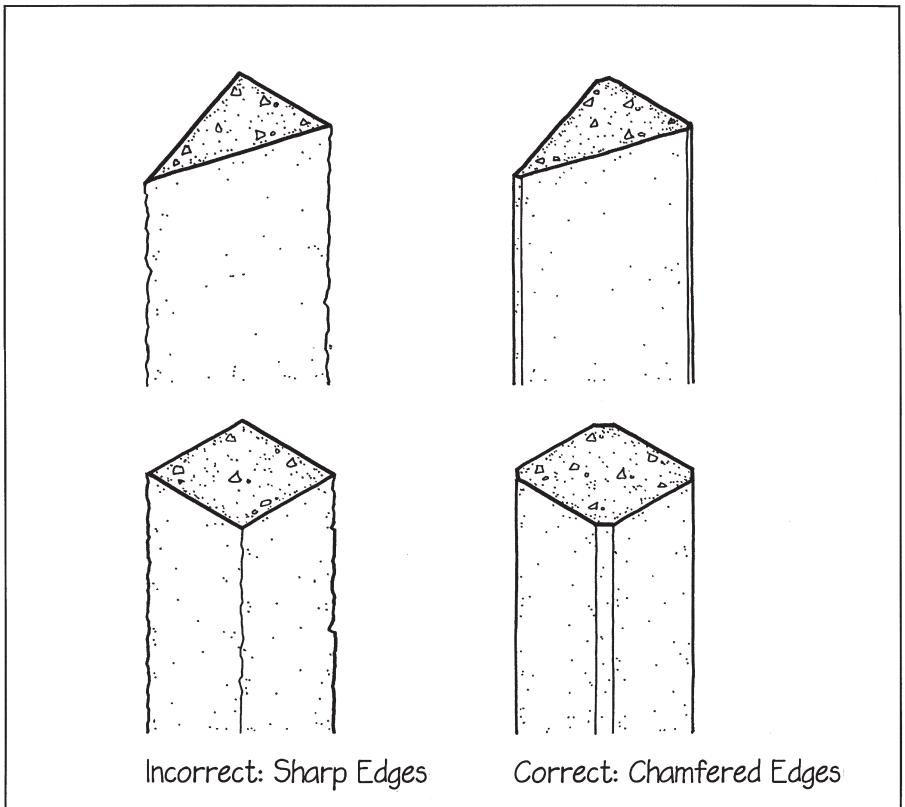
Clean Edge

Where a material or a surface ends, it should do so neatly and decisively.

1. Two kinds of edges that are unforgiving are sharp edges and feather edges. Sharp edges are dangerous and are very susceptible to damage before, during, and after construction. If damaged, they are almost impossible to repair. Feather edges are created when we try to smooth one material into another, as in joining a plaster wall to a masonry wall that lies in the same plane, by smoothing the edge of the wet plaster onto the face of the masonry. A feather edge looks terrible and is so fragile that it usually cracks apart in a short period of time. It is also impossible to make a smoothly feathered edge in anything but very fine-grained plaster or drywall finishing compound. It does not work, for example, to try to create a feathered wash with mortar on top of a masonry chimney: The sand in the mortar is too coarse to feather, and the thin, insubstantial wash will soon crack and detach itself from the masonry. Instead, a chimney should be terminated with a reinforced concrete cap that has a clean, thick edge and a wash on the top.



1. Chimney Cap Edges

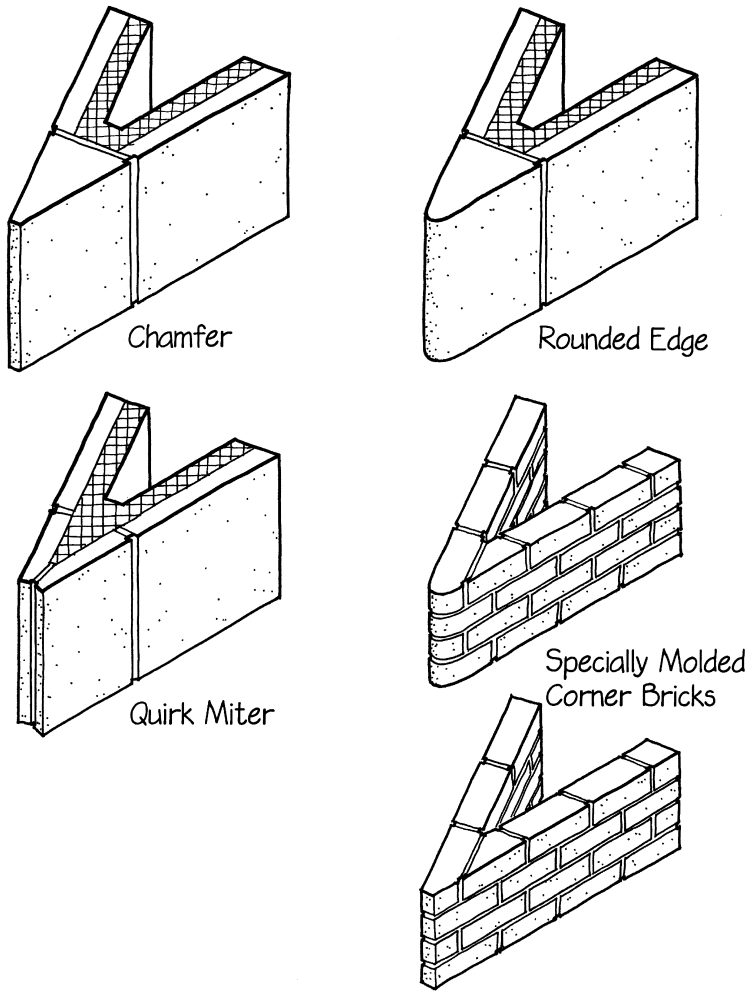


2. Edge Details for Concrete

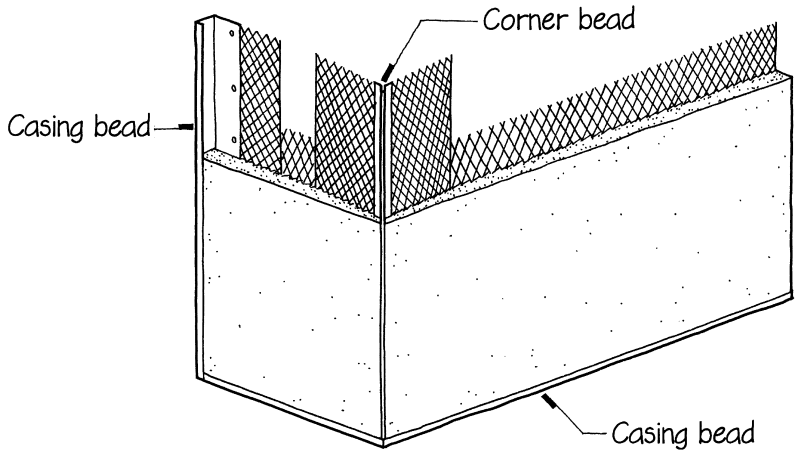
2. Venture to make sharp edges on concrete only when the crew's control of concrete placement is of the highest caliber. Sharp edges in formwork often do not fill properly with concrete during pouring and are likely to be damaged when the formwork is stripped—an operation that takes place while the concrete is still weak and very brittle. Use chamfer or fillet inserts in the corners of formwork to eliminate sharp corners on concrete; even 90 degree corners are dangerous, unattractive, and difficult to do well if the designer tries to keep them sharp. Furthermore, they are much more susceptible to damage during construction and occupancy. If sharp corners are required, then the concrete specification and placement methods must be adjusted to be sure that the concrete fills the tight corners. Coarse aggregate, low-workability concrete, and under-vibration can all result in voids rather than filled corners. Formwork removal must also be done cautiously to avoid damaging the vulnerable corners. Some damage is virtually certain, and even the best of repairs will be obvious to the eye. ▷

3. Sharp angles on stonework and masonry are also unforgiving of minor construction mishaps and are very difficult to repair. Chamfered edges, rounded edges, quirk miters, and reveals are clean, forgiving edge details for sharp masonry corners. To create these types of corners in brickwork, specify specially molded brick shapes. Acute-angle corners that are woven of square bricks have water-catching recesses that lead to premature deterioration. Bricks that are cut to an angle with a hammer or a saw have an unattractive and porous finish on the cut surface.

4. Exposed edges of plaster, stucco, and gypsum board must always be bounded by the appropriate casing beads and corner beads. These help the plasterer to maintain a constant thickness of wall and to create clean edges that join neatly to surrounding materials. There are also many accessory strips manufactured in metal and plastic that the detailer can use to create crisp, cleanly finished reveals and joints in plaster surfaces. ■



3. Clean Edges on Sharp Corners of Masonry



4. Clean Edges on Plaster and Stucco Surfaces

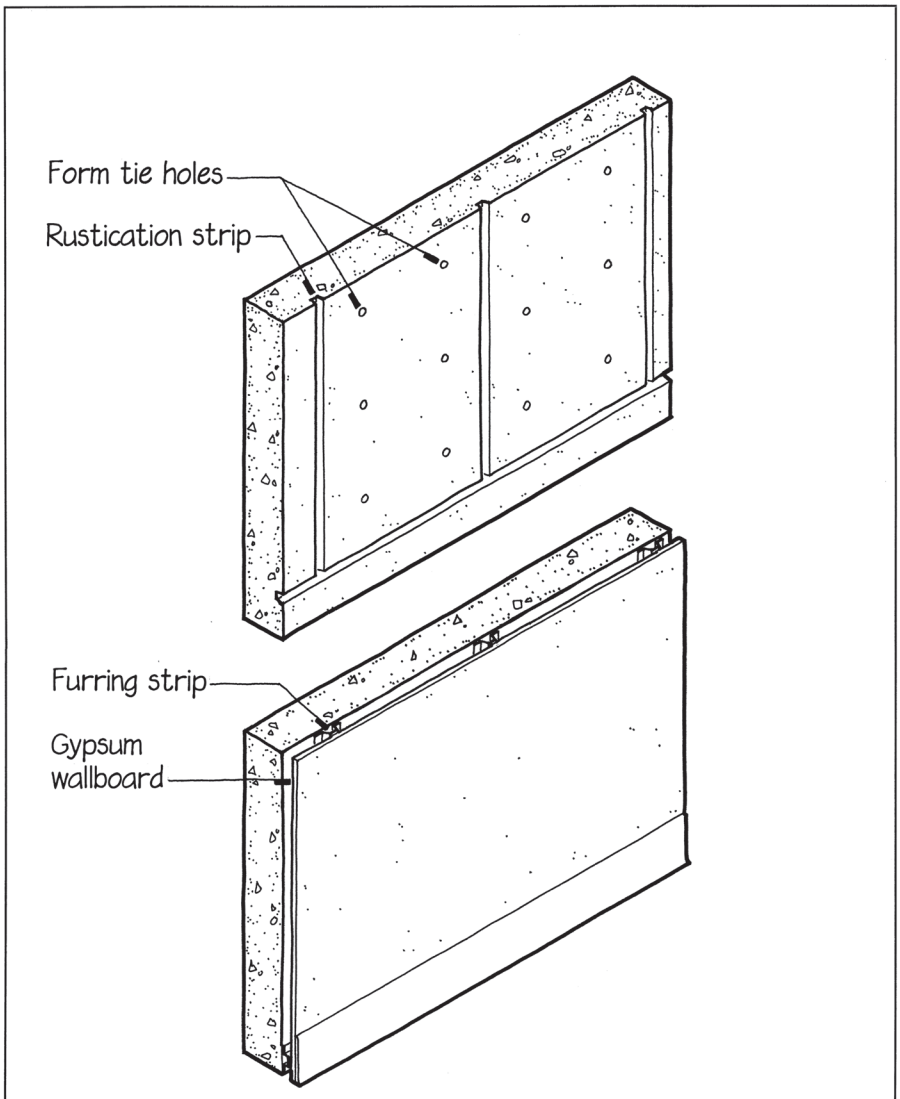
Progressive Finish

As a construction process progresses, each stage of work should be more finished than the stages that preceded it, and the installation of fine finishes should be delayed until as late in the construction process as possible.

1. Imagine two different ways of finishing the interior side of a wall of poured-in-place architectural concrete. One way is simply to form and pour the concrete very carefully and leave it exposed. The other is to form and pour the concrete somewhat less carefully and then, late in construction, furr its interior surface and add a finish layer of gypsum wallboard and paint.

The exposed concrete surface would seem to be the more direct, simple, secure, and economical option to choose, because it involves less material, fewer steps, and fewer trades. It is, however, a very unforgiving finish. Any defects in the formwork and ties, any inconsistencies in vibrating the concrete, any cold joints or slight differences in color between batches of concrete, and any staining or damage to the wall during subsequent stages of construction will be painfully obvious in the finished surface.

Using furring and gypsum wallboard, the concrete work can be done in a much less exacting way, and any subsequent construction damage to the concrete surface appearance will be of little consequence. After most construction operations are done and the wall is completely sheltered from the weather, the furring strips are mounted to the concrete, shimming if necessary to produce a plumb, flat surface. The wallboard is mounted, taped, spackled, sanded, and painted. Its junction with the floor is concealed behind a baseboard. Any last-minute damage to the gypsum wall, even if someone puts a wrench or a foot through it, can be repaired quickly and invisibly with drywall compound and paint. The overall cost of the concrete wall plus painted gypsum finish may be less than the overall cost of simply exposing the concrete wall. This is because the wall with a painted gypsum finish has been finished progressively rather than in a single, irrevocable step. The progression is from rough, crude structural surfaces to finer gypsum surfaces to very fine surfaces of paint, with the rough edge covered by a baseboard.



1. Exposed Concrete Versus Furred Gypsum Finish

Progressive finish involves successively better approximations of the degree of finish ultimately desired, and it delays the finer degrees of finish until as late as possible in the construction process, to avoid their being spoiled by rougher operations.

Of course, a painted gypsum surface does not have the satisfying solidity and character of a well-made concrete wall. The client and the designer may prefer the concrete, and in that case they should have it, but they must recognize that it is an unforgiving finish, expensive and risky to produce, and difficult to repair. It must be detailed, specified, supervised, and budgeted accordingly. ▷

SECTION 3

AESTHETICS

A building should please the eye. It should go beyond function and constructibility to engage the mind, and even the heart. Its details play a large role in this important function. Every truly great building has great details: details that contribute to the aesthetic themes of the building, that harmonize with one another, and that create beauty out of the ordinary materials and necessities of construction. A building with a splendid thematic idea can fail as architecture if it has poor details that are badly matched to its primary aesthetic, that do not relate strongly to one another, and that fail to lift their materials above the ordinary.

The detail patterns that relate to aesthetics are few in number, but each is powerful and far-reaching, and they require greater effort and insight to implement than any of the patterns relating to function and constructibility. For the following nine detail patterns, see the corresponding sections in Chapter 14.

The foremost aesthetic requirement for detailing is that all of the details of a building should contribute to its formal and spatial theme. Aesthetic features of details should be as appealing in future years as when they were built. These requirements are developed in the detail patterns:

Contributive Details (p. 235)
Timeless Features (p. 238)
Geometry and Proportion (p. 239)

Details may be elaborated to feature certain inherent characteristics, or they may be decorative, for purely visual or experiential effect:

Hierarchy of Refinement (p. 241)
Intensification and Ornamentation (p. 243)
Sensory Richness (p. 245)

Lastly, details may be developed whose role is to unify and give order to the visual composition of building elements that otherwise might seem disjointed or unrelated. This role is introduced in the patterns:

Formal Transitions (p. 246)
Didactic Assemblies (p. 249)
Composing the Detail (p. 250)

These nine patterns serve to focus the detailer's attention on some important aesthetic issues that arise in detailing. They constitute a small part of a much larger field of study—architectural composition—that will amply repay as much as the time that detailer can devote to its study.

The body of built architecture from antiquity to the present provides evidence of the importance of the link between art and craft. Classical Greeks originated the notion of *techne*, derived from the Greek verb *tikto*, meaning "to produce". This term means the simultaneous existence of both art and craft, deliberately avoiding distinction between the two.

Architectural details can convey to the observer in literal terms the facts about the form and how it is made. They can also reveal what is latent within the form, features so subtle that they are not consciously noticed by the casual observer. In the following patterns, the term "aesthetics" will be used to describe features that recognize the inextricable link between art and craft, between the ideal and the circumstantial, and between the concept and its tangible embodiment. In architectural detailing, ideas must be made real.

The detailer is challenged to find solutions that solve the specific technical requirements of a given detail, while also showing affinity with the building's central aesthetic themes. Some details may seem to have no solutions; others may have many. The best solutions are functional, convey meaning, and reward the senses.

Although the emphasis in this section is on the visual qualities of a building and its details, the detailer should always look for opportunities to delight the other human senses. Tactile qualities of materials and details are important: the feel of a carpet or polished marble underfoot; the satiny smoothness of polished wood handles on a cabinet; deep, luxurious cushions on a bench; a nubby texture in a wallcovering. Auditory qualities are also vital: Should a particular architectural space seem hushed and quiet? Should it be vast and echoey? Should one's footsteps resound throughout a room, or would it be more appropriate that one tread softly, as if floating noiselessly? Would it enhance the architectural experience if one heard the sounds of splashing water, of birdsongs, of wind in trees, of children chattering, of machines working productively? And consider the opportunities for olfactory delight in a building: the fragrance of cedarwood, the perfume of flowers, the freshness of grass growing, the moist breezes off a pond, the waxy smokiness of candles, the musky scent of leather. Once again, the designers of the greatest buildings have considered these possibilities and have often used them to their advantage.

CHAPTER 14

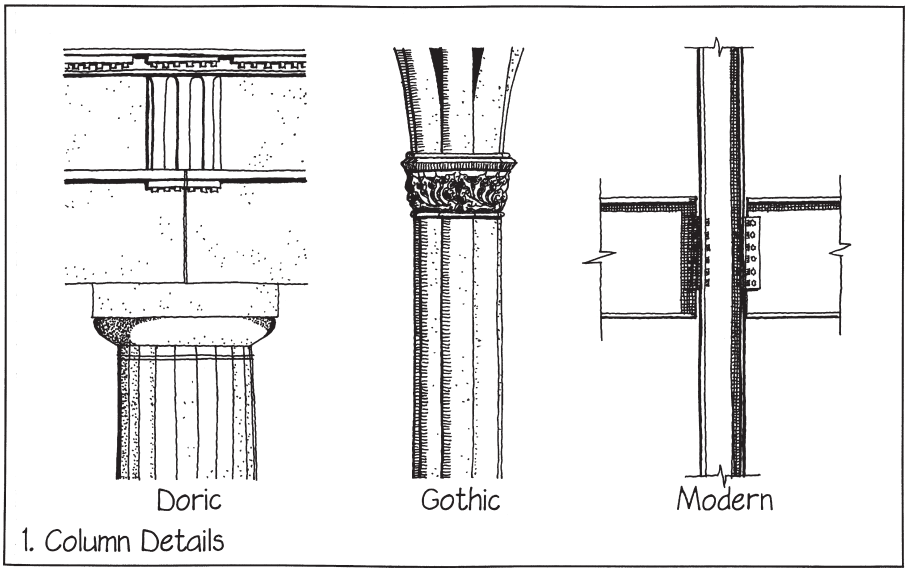
Aesthetics



Contributive Details

All of the details of a building should contribute to its formal and spatial theme.

1. Every detail has a style. The style may be the incidental by-product of practical actions, as might be found in good vernacular architecture, or the intentional expression of a particular language of architecture, such as the Doric order. A Doric temple is much more than just a low gabled roof supported by closely spaced columns that encircle a walled rectangle. It is also a particular set of subtle proportions with a consistent set of intentional details, each of which contributes to the overall appearance that we recognize instantly, not just as traditional, not just as classical, but as Doric.



1. Column Details

The Gothic style was based on an obsession with tall, long spaces lit by generous windows. It encompassed a structural ideal of elaborate stone vaulting supported on slender piers, its thrusts absorbed by delicate buttressing, and a set of details very different from those of Doric builders. Whereas the Doric order's details emphasized a thick, discontinuous, sticklike constructional aesthetic, the Gothic featured thin, flowing members that all contributed to an apparent continuity of space, form, and structural action.

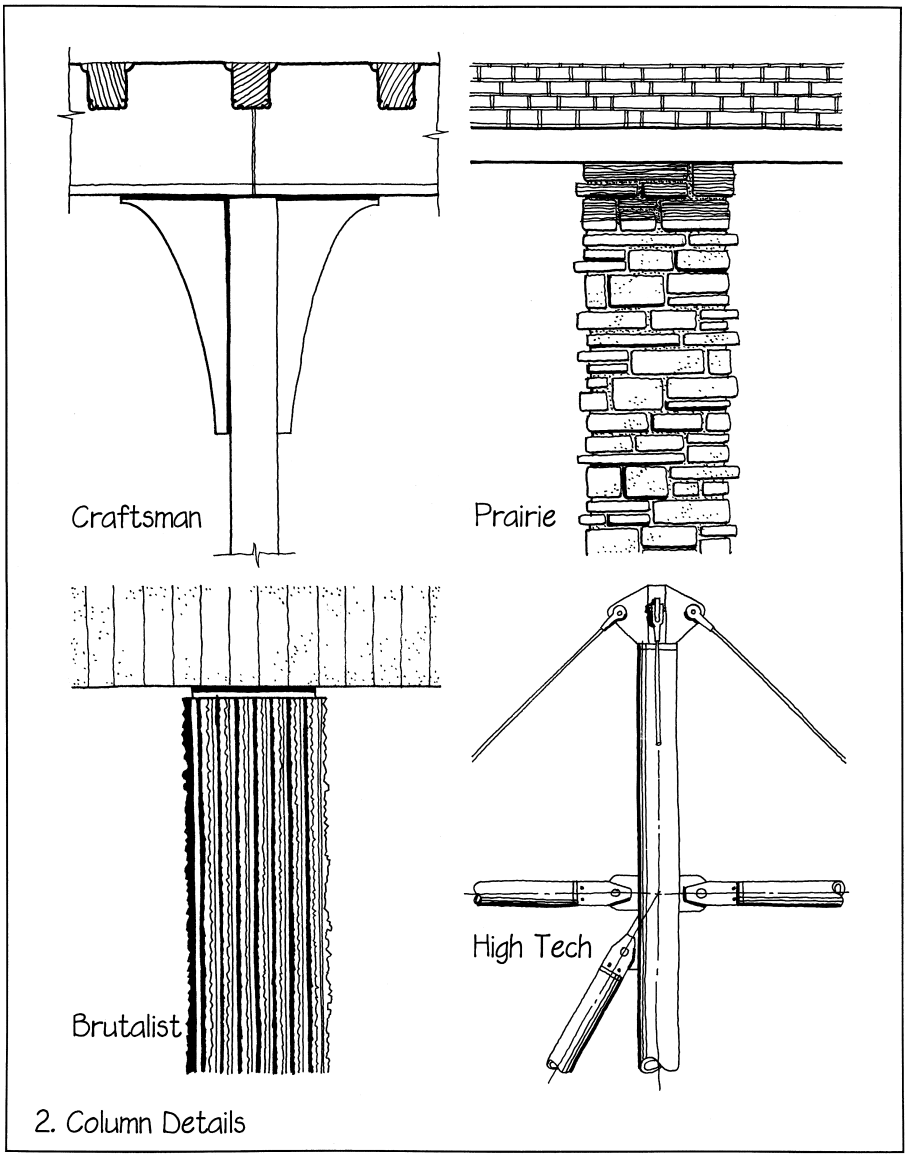
The modern style advocated the truthful expression of material and unornamented functionalism. The theme of continuous or universal space was well served by the minimalist steel frame and transparent glass skin, eliminating all that was not essential. Rather than carved stone, the modern column takes raw minerals and transforms them into man-made materials whose properties and shapes are rationally controlled. ▷

2. In similar fashion, we can analyze the details associated with any architectural style: Craftsman style with its celebration of wood joinery; Prairie style with its details that emphasize horizontality (sometimes even to the point of turning all exposed screws so their slots are horizontal); various Brutalist styles, in which slabs and sticks of material seem to bang into one another without visible connectors; High-Tech style, in which the parts of a building are made to look like the pieces of a precision machine, joined with visible bolts and pins, and of course Contemporary styles in which layers of abstract materials and discrete connections prevail.

3. Try to imagine a building by Ludwig Mies van der Rohe with Victorian Gothic details: If we could succeed in creating it, its composition would be so riven by internal conflict that it would fall apart compositionally before our eyes. The minimalist spaces and forms of a building by Mies are appropriately enhanced by minimalist details; if they are not, it is not a Mies building. Try to imagine a Romanesque-style building with High-Tech details or a Baroque building with Brutalist details. It is impossible for compositions of such varied attitudes toward details to be resolved. A building's details are integral to its style.

4. Every designer of buildings works in his or her own manner; it may not have a name, but it has a consistent personality or a guiding ethic. This personality or ethic stems from an approach to space, to form, to light, to color, and to details. The style of the details must be integral with the style of the building. As a designer's manner evolves and changes with each project, so must the details. The details must contribute their proportional share to the character and content of the building. For some architects, a particular material or detail is the seed from which the building's design grows. Even if not the source of the central design concept, details are the voice of the concept, the means through which the concept is expressed.

5. Vernacular architecture abounds with examples of contributive details, not because of its intellectual rewards, but simply because building features, large and small, all come from common sources. Their creators' common cultural roots, common skills, and common material palettes implicitly guide actions along a common path. It helps that vernacular buildings often reveal themselves honestly in straightforward, unembellished assemblies, so their features are not masked. Poetic expression is sometimes the residue of insightful work with limited means, not due to stylistic preferences.



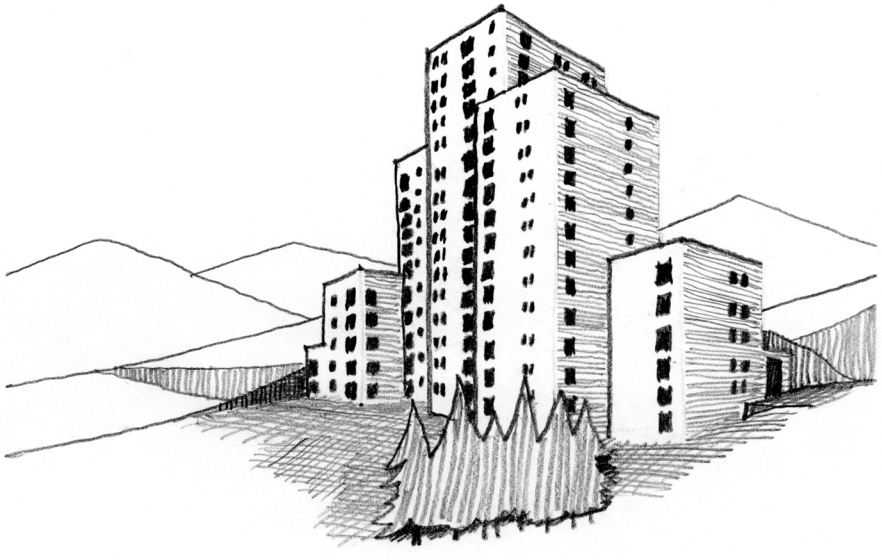
2. Column Details

6. A building's details should be all of a family. It will not do to copy one detail from one source, another detail from another source, and patch together a set of details that function well but bear no visible resemblance to one another. The designer should develop a matched set of a building's most important details as an ongoing part of the overall design process. This set of key details should then serve to guide the preparation of every other visible detail in the building. Details may become related by sharing a common compositional approach, which may be evident in their proportions, materiality, alignment, and orientation.

PART

II

DETAIL DEVELOPMENT



CHAPTER 15

Detailing a Building in Wood Light Framing

THE PROJECT

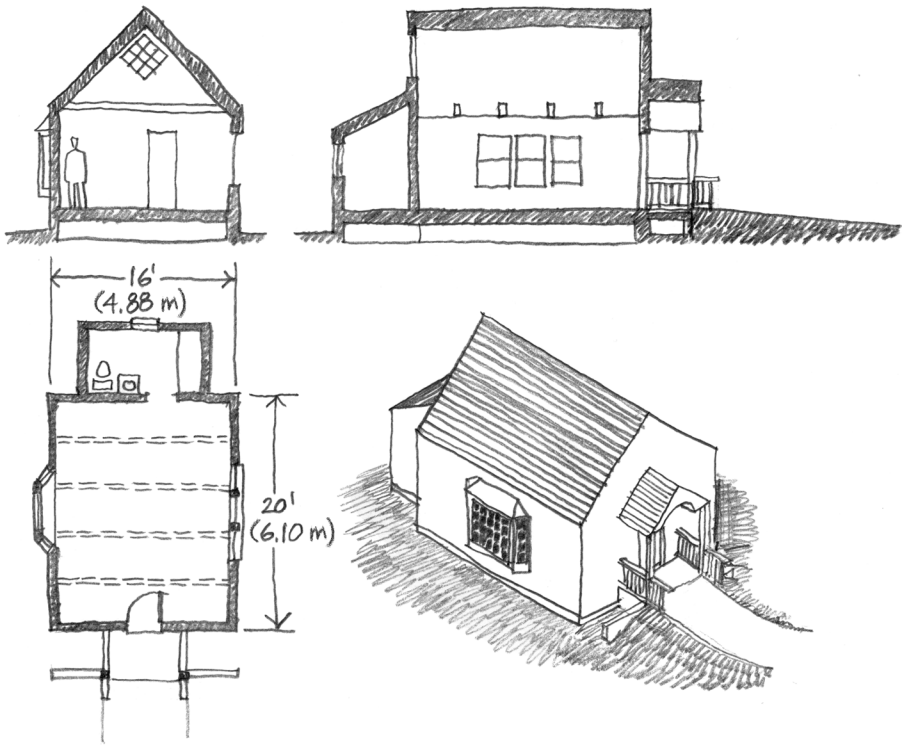
The project is a small sales office for a residential subdivision in coastal New England in IECC (International Energy Conservation Code) Climate Zone 5. The roof pitch is 12/12 (45°). Both the roof and the walls will be clad with red cedar shingles *(**Surfaces That Age Gracefully***, Chapter 10*)*. The interior will be finished with gypsum board walls and ceiling and a varnished oak floor.

SETTING PERFORMANCE STANDARDS

We wish the building to convey the image of an uncomplicated cottage with a minimal, prismatic form (***Timeless Features***, Chapter 14). The details of the building should be as simple as possible to contribute to the minimalist, geometric architectural image, and they should relate closely to one another.

Although smaller than many residences, this is actually a commercial building in terms of the building and energy codes. We have the option of using whole-building energy performance as described in IECC energy code Section 407, but this process is more complex than using the prescriptive tables found in Chapter 4 of the IECC. We will proceed using the prescriptive minimum ***Thermal Insulation*** (Chapter 3) values that follow. Metric equivalents are shown in parentheses.

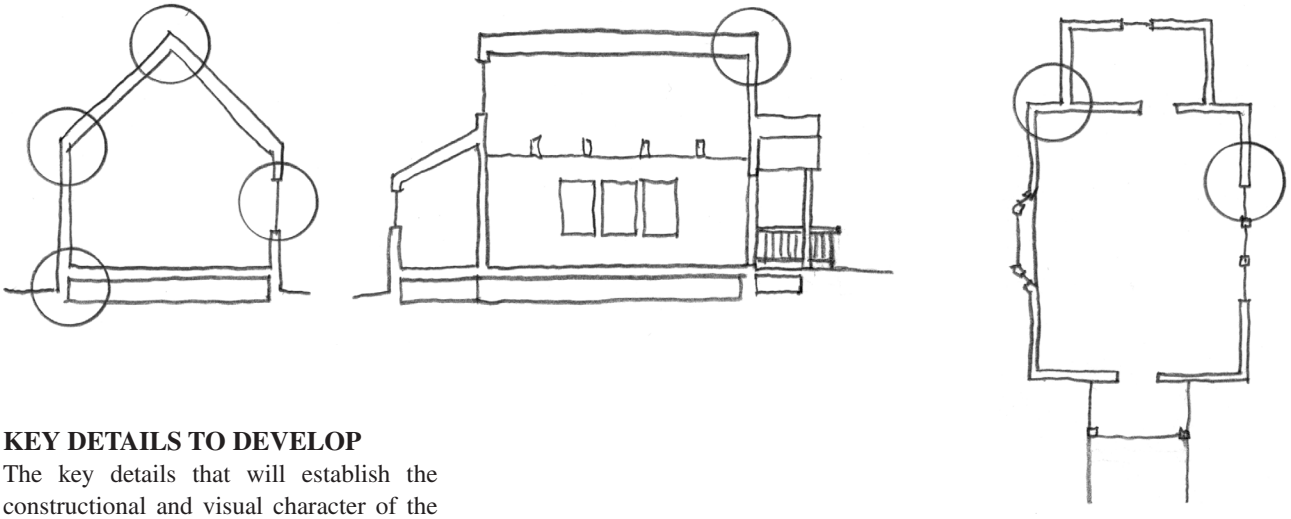
Walls: R-13 between studs + R3.8 continuous insulation *or* R-20 if only between studs (R-90 + R-26 *or* R-139)



Roof: R-38 if between rafters *or* R-25 if continuous insulation (R-264 *or* R-173)

Floor: R-30 (R-208) if above an unconditioned space.

We will exceed the minimum value slightly by using R-23 (R-160) mineral wool high-density batts for wall insulation between studs to reduce energy consumption and cost (***Life Cycle***, Chapter 10). The roof insulation must be done in a manner that allows the ceiling to follow the line of the rafters to create a tall interior space. ▷



KEY DETAILS TO DEVELOP

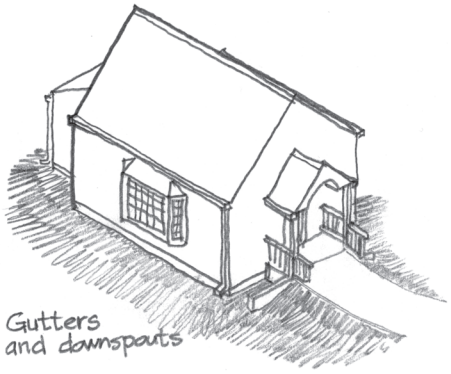
The key details that will establish the constructional and visual character of the building are those circled on the accompanying section and plan diagrams.

These must be developed as a consistent set of ***Contributive Details*** (Chapter 14) that work well with the building's architecture and with one another. They are the most general of the building's details. Details of special situations, such as the entry porch and the shed to the rear that houses the toilet room, will be developed using these general details as a point of departure.

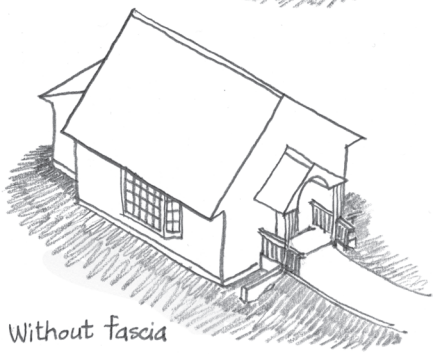
EARLY WORK ON FORM, MATERIALS, AND DETAILS

The prismatic form that we have envisioned presents an eave-detailing problem: Under most circumstances, storm drainage from the roof would be collected in gutters and downspouts, which would disrupt the clean geometry of the building. Gutters could be built into the roof surface at the top of each wall, but we discard this idea because built-in gutters often prove to be troublesome in use. When they become clogged with leaves or ice, water is likely to back up under the shingles (see ***Unobstructed Drainage***, Chapter 1).

The building code requires that water from the roof either be collected in storm drainage systems such as gutters, or discharged onto ground surfaces such as paving or landscape surfaces, provided that the stormwater flows away from the building. If an eave overhang of at least 1 ft. (305 mm) is provided, no gutters are required because the overhang is an ***Overhang and Drip*** (Chapter 1) that protects the walls and windows. If we adopt this alternative, however, we will want to detail a drip trench

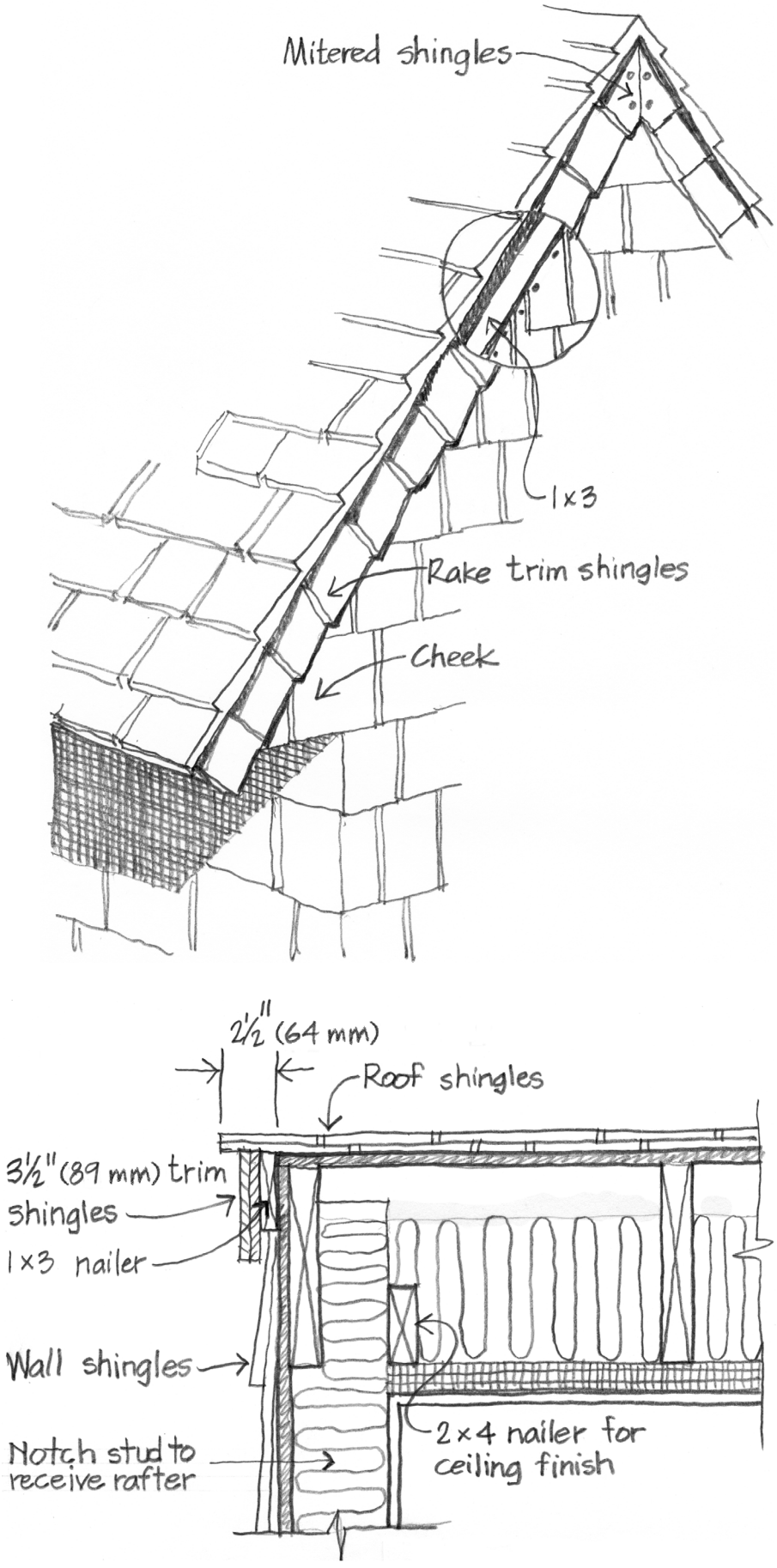


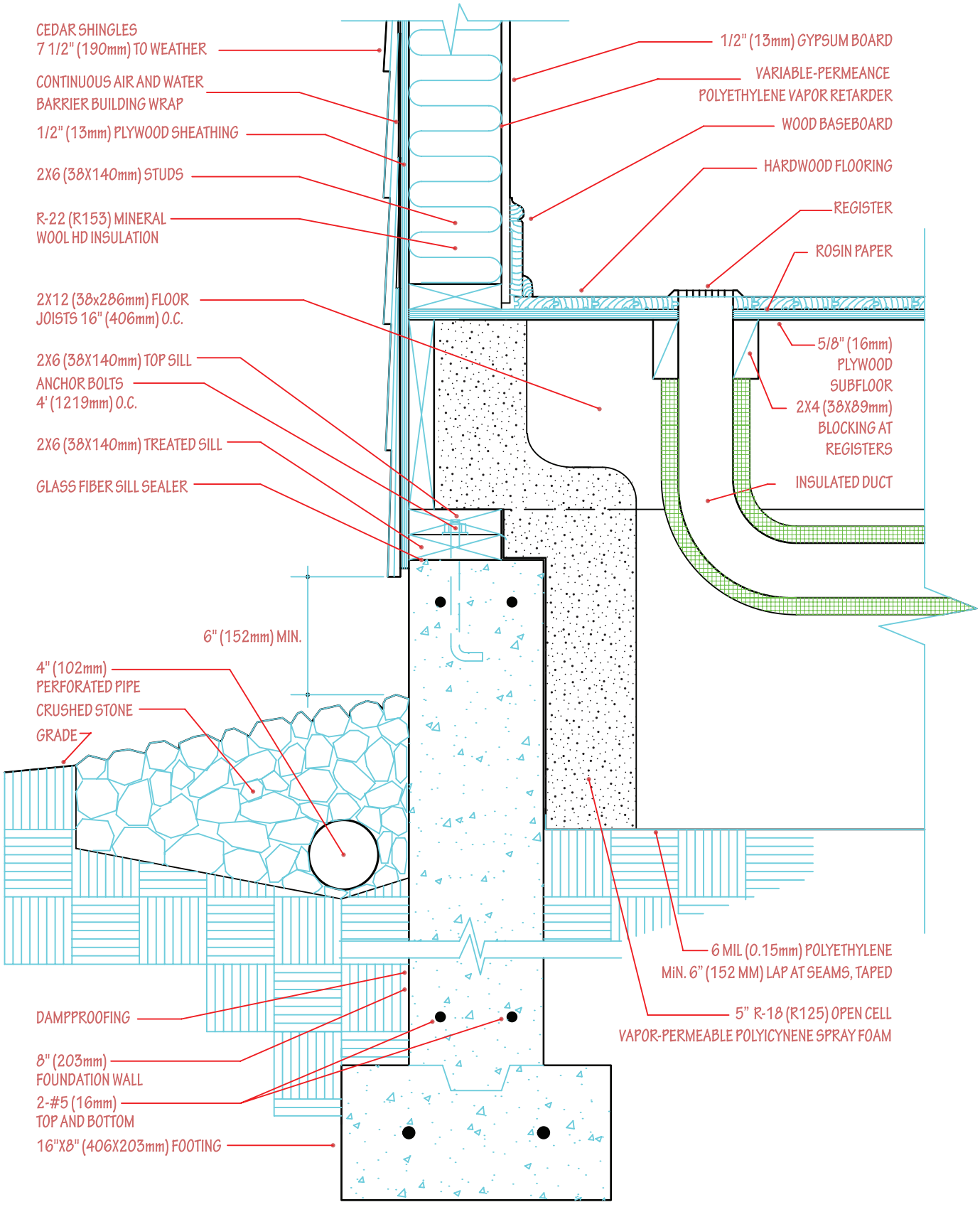




shingles onto it. The spacing of the rake trim shingles can be matched to the spacing of the roof shingles for a neat appearance. The last rake trim shingle at the bottom can be left square, as shown, or cut off level, as dictated by appearance considerations. At the ridge of the roof, the two rake trim courses can intersect with a miter. The two mitered shingles will be the only ones on the facade that will have exposed nail heads, unless a mastic construction adhesive is used to glue these two shingles in place, which may not bond well and would make future reshingling difficult (***Expected Life***, Chapter 10).

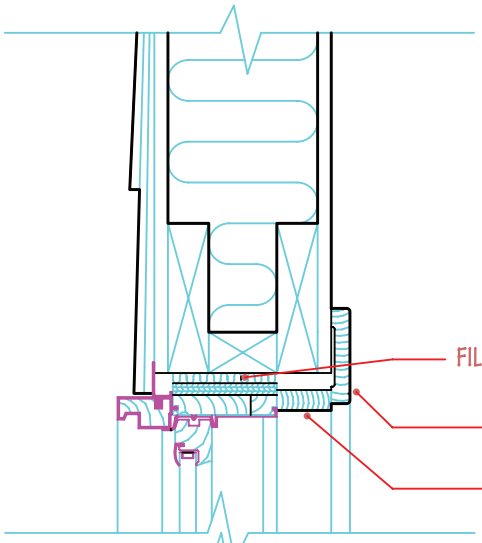
There is one other aspect of the rake detail that requires our attention, and that is the framing of the triangular wall of the gable. Carpenters are accustomed to building houses with attics, but our building has none. In houses with attics, the wall studs in the gable ends are normally interrupted at ceiling level by a double top plate, and short studs on top of this plate are used to frame the triangular gable. The top plate is supported laterally by the attic floor. In our building, which has no attic floor, this type of framing would not be strong enough against wind loads. The gable wall studs in our building must be single pieces that stretch from floor to rafter. We scale an elevation drawing to find that the longest stud will be about 15 ft. (4.6 m) tall. We are using 2 × 6 studs 24 in. apart (38 × 140@610 mm). Are these strong and stiff enough for such a tall wall? We check a table in the building code and find that they are. We know from experience that carpenters will not frame the end walls with full-height studs unless we tell them to do so, so we make a note to call this out on the elevations and sections of the construction drawings. ▷





FOUNDATION DETAIL
Scale 1 1/2"=1' (1:8)

HEAD

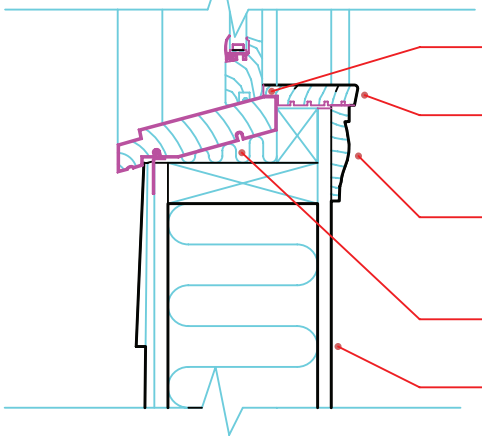


FILL WITH FOAM OR GLASS FIBER INSULATION

11/16" X 3 1/2" (17X89mm) CASING

3/4" X 2" (19X38mm) HEAD EXTENSION

SILL



SEALANT BETWEEN STOOL AND SILL

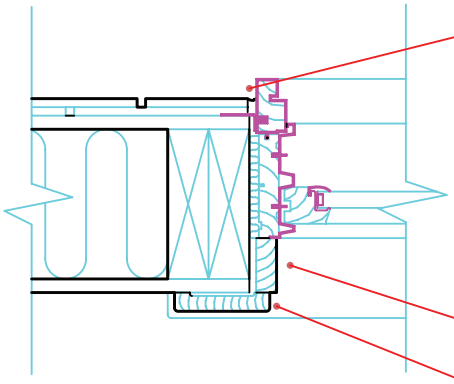
3/4" X 3 1/2" (19X89mm) STOOL
WITH RELIEVED BACK

11/16" X 3 1/2" (17X89mm) APRON
WITH RETURN MITERED ENDS

FILL WITH INSULATION

GYPSUM BOARD

JAMB



1/4" (6mm) SEALANT

FOLLOW MANUFACTURER'S INSTRUCTIONS
REGARDING INSTALLATION OF
CONTINUOUS AIR AND WATER BARRIER
BUILDING WRAP AT ALL PENETRATIONS

3/4" X 2" (19X38mm) JAMB EXTENSION

11/16" X 3 1/2" (17X89mm) CASING

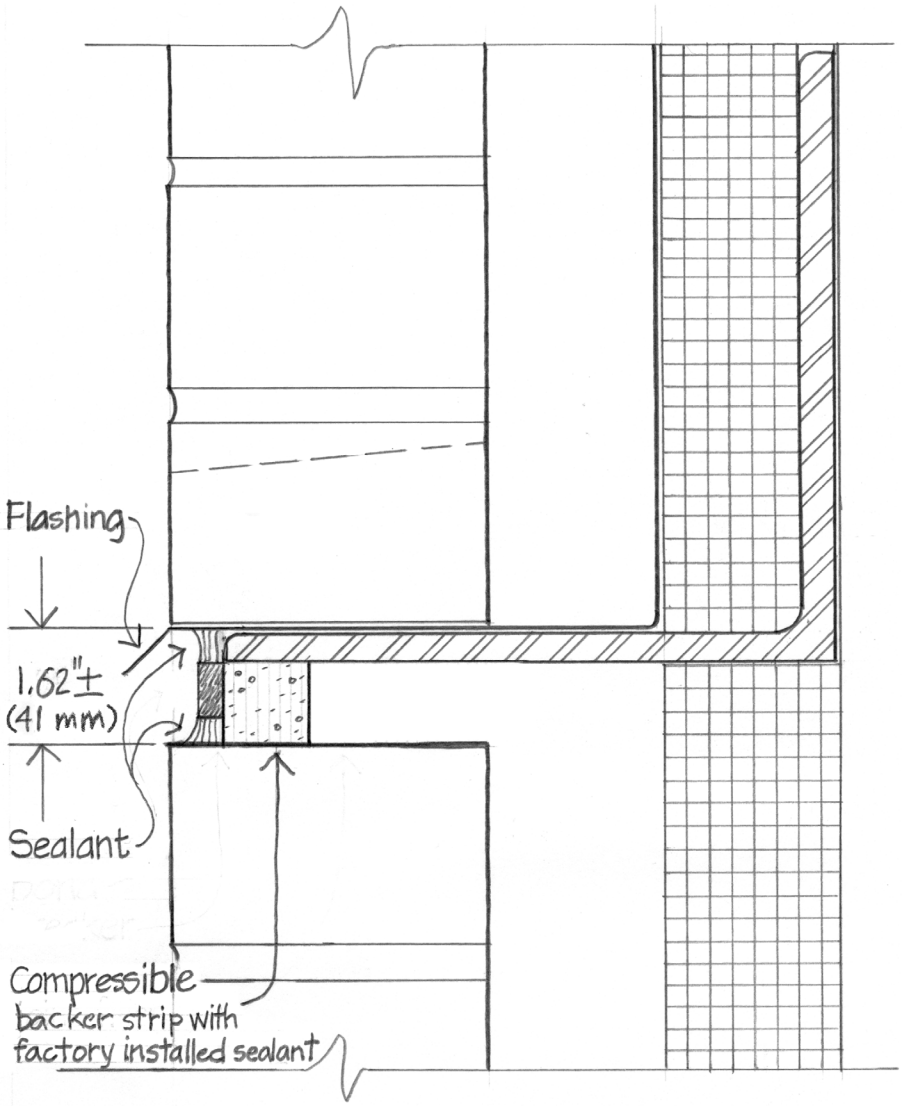
WINDOW DETAILS
Scale: 1 1/2"=1' (1:8)

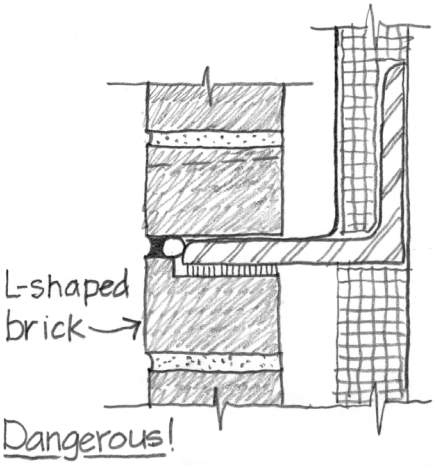
Detailing the Soft Joint

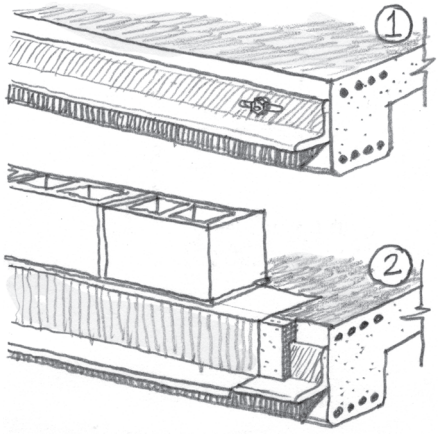
We need to look more closely at the construction of the shelf angle, soft joint, and flashing. For this we find that we need a larger scale of drawing, so we prepare a detail at one-half full size. The soft joint that we propose is 1¼ in. (32 mm), which is unusually thick. The traditional standard ⅜ in. (9.5 mm) joint is grossly inadequate for a concrete frame building. We have made the joint this thick because we are being extremely careful to allow for the creep and deflection that we expect in the concrete frame (***Expected Life***, Chapter 10). We make a note to check the availability of low-density rubber compressible filler strips in the thickness we need. We will select a type that has a factory-installed sealant applied to the exposed face, reducing the height of the field-installed sealant to two beads of about ⅜ in. each. This avoids having a very tall sealant joint that may sag out before it cures.

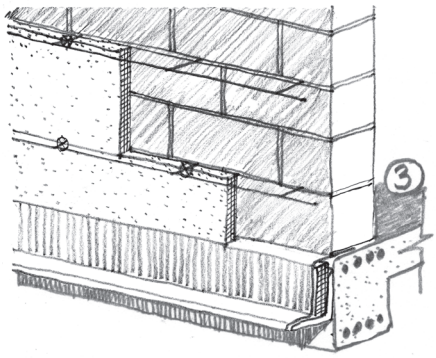
Many architects try to hide the soft joint by minimizing its thickness, recessing the outer lip of the flashing into the mortar joint, and using L-shaped bricks to conceal its additional thickness. These are all dangerous expedients. An alternative is to select a different color of brick for the first course to be laid on the shelf angle. The eye goes to the horizontal band of differently colored brick; minor features such as joint thickness and weep holes are much less noticeable.

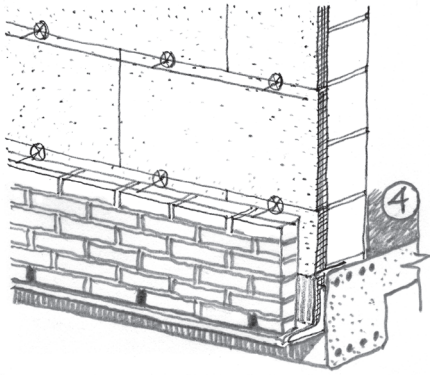
A soft joint that is too thin will not be able to absorb all the movement that occurs, and the brick facing may be put under a structural load that will cause it to crack and buckle. A recessed flashing leads to a wet shelf angle that can corrode. The lips of L-shaped bricks are fragile and subject to freeze-thaw spalling.











Detailing the Air Barrier

Returning to the original section drawing, we ***Rehearse the Construction Sequence*** (Chapter 13) to see if it makes sense.

First, ironworkers will install the shelf angles, setting them to accurate alignment marks that surveyors have left on the perimeter beams (1). Next, the masons will begin their work by installing the foam strips and flashings over the shelf angles, lapping and sealing the flashings at end and corner junctions. Then they will lay the first course of concrete blocks in the backup wall, which brings them to the height at which the first strip of metal joint reinforcing and ties must be placed (2). This strip, once in place, will obstruct any further work in the cavity, so we realize that the air barrier, insulation, sealant at the column faces, and brick facing must be completed up to this level before the strip is installed. This forces us to think more deeply about these components of the wall.

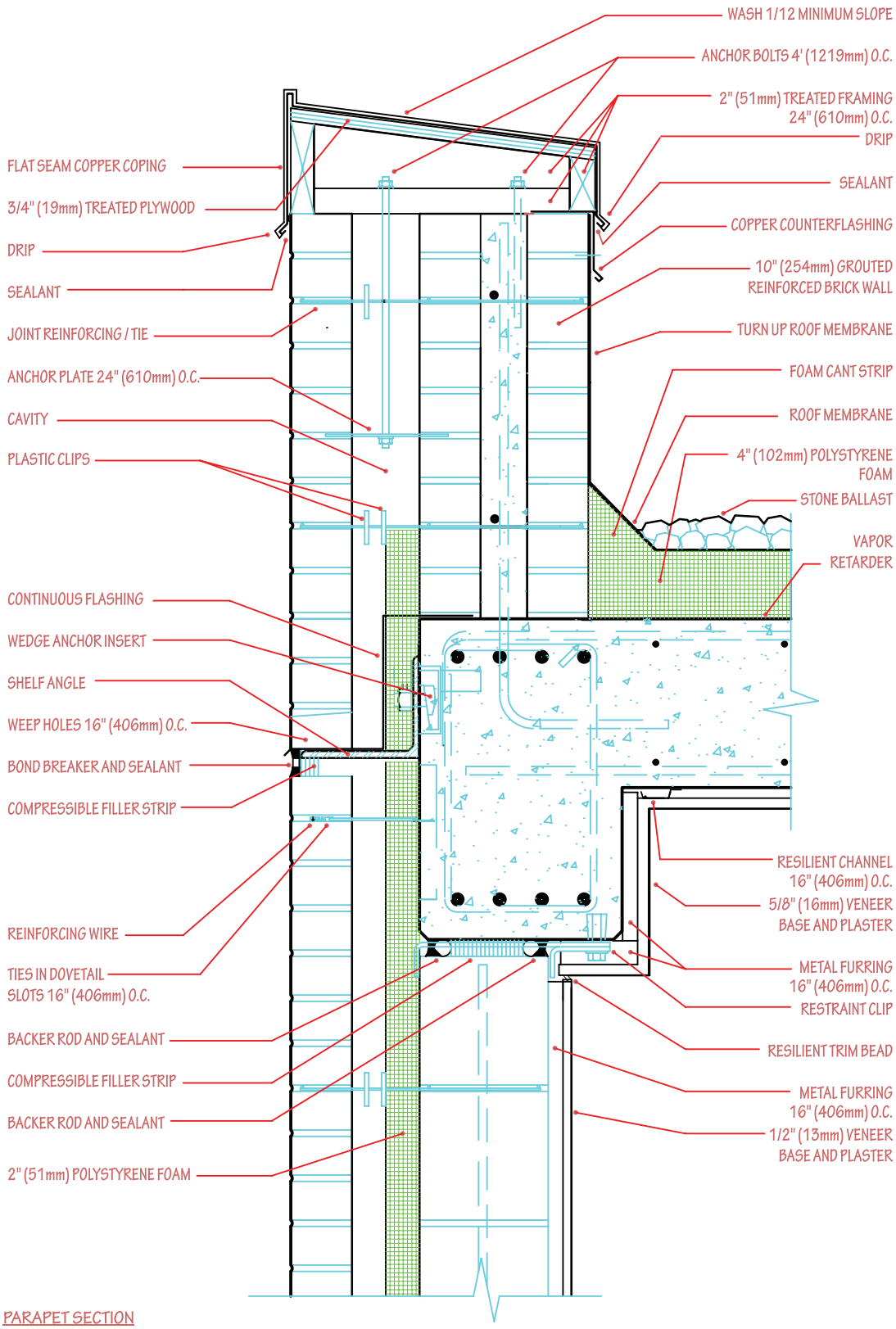
A bit of catalog research reveals that there are two general types of air barrier materials available for cavity walls: flexible sheet materials that are adhered or fastened mechanically to the backup wall, and asphaltic or synthetic fluid-applied mastics that are troweled or sprayed onto the wall. We note that some of the sheet materials are available in widths that are designed to match the every-second-block-course spacing of ties that we are using. This is handy, but we also notice that the sheet materials must be cut to fit around the ties, and a mastic must then be used to seal these penetrations. We also see that for the adhered systems, the blockwork must be primed with a coating that takes at least an hour to cure before the sheet material can be adhered. These all seem like severe disadvantages, especially the curing time, which might delay the progress of the work. Fluid-applied mastics have none of these disadvantages. Compared to the sheet materials, they would simplify the masons' work greatly. However, if some mastic should slop onto the top surface of the concrete masonry, it would destroy the adhesive bond of the mortar to the blocks and weaken the wall. We decide to adopt a mastic air barrier, but we make a note to specify that it be held back 1 in. (25 mm) from the upper edge of the blocks until the next two courses have been laid. We also note that the sealant joint where the backup wall meets each column must be completed before the mastic is spread, to avoid mastic contamination of the surfaces to which the sealant must adhere.

To rehearse again the masons' work thus far: They must install the first strip of foam insulation over the shelf angle, place the flashing, and lay the first course of concrete blocks in the backup wall. The waterproofing subcontractor would then install backer rod and sealant on the outside face where this course meets the columns at either end (the inside sealant joints can be done later), and spray on the air barrier mastic. Then the masons must install the next strip of foam insulation, only 8 in. (203 mm) high, pressing it against the mastic. This raises a problem: We were going to specify that the mastic coating be held 1 in. (25 mm) below the top of the concrete masonry, to be continued from that level after the next block courses have been laid. But once the foam insulation is installed, it will be impossible to get behind its top edge with a trowel to continue the mastic work as an unbroken air barrier membrane. We must rethink the sequence.

Suppose that we have the masons do everything as we have already planned, but leave out the foam for the moment, constructing the first six courses of brickwork instead. Then they could place the strip of foam insulation loosely in the cavity, install the joint reinforcing and tie strip above the insulation (3), and lay the next two courses of backup blocks. At this point the backup wall would be 16 in. (406 mm) higher than the brick facing. The waterproofing subcontractor could then apply the sealant at the junction between the columns and the backup wall, and spray on the next strip of mastic, being careful to seal around the ties and over the top edge of the previous strip of mastic. All of these steps can be observed by the office's construction administrator (***Observable Assemblies***, Chapter 11).

Next, the masons could reach through the ties into the cavity to push the 8 in. (203 mm) strip of insulating board into position, locking it in place with standard plastic clips that snap over the ties (4). This would seem to work more smoothly than the first scenario, presenting fewer problems of worker access. Each clip is designed to hold the top of one sheet and the bottom of the next. The strip of foam just above the flashing would have no bottom restraint, but we could get around this by asking the masons to daub some spots of mastic onto the back of the foam with the tip of the trowel just before pushing it into place and installing the clips (***Accessible Connections***, p. Chapter 11).

This option is appealing, but is still less than ideal because it is likely that the mortar colors for the block and brick wythes will be different, and they may get confused by the masons on the scaffold. Another concern is that the crews of masons and mastic installers may be crowded on the scaffold, each crew trying to carry out its work at the same time (***Minimum Number of Parts*** and ***Repetitious Assembly***, Chapter 11). ▷



PARAPET SECTION
Scale 1 1/2"=1' (1:8)

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Detail patterns are in ***bold italics***.

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