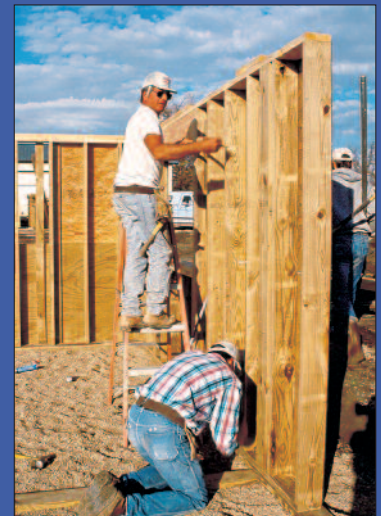
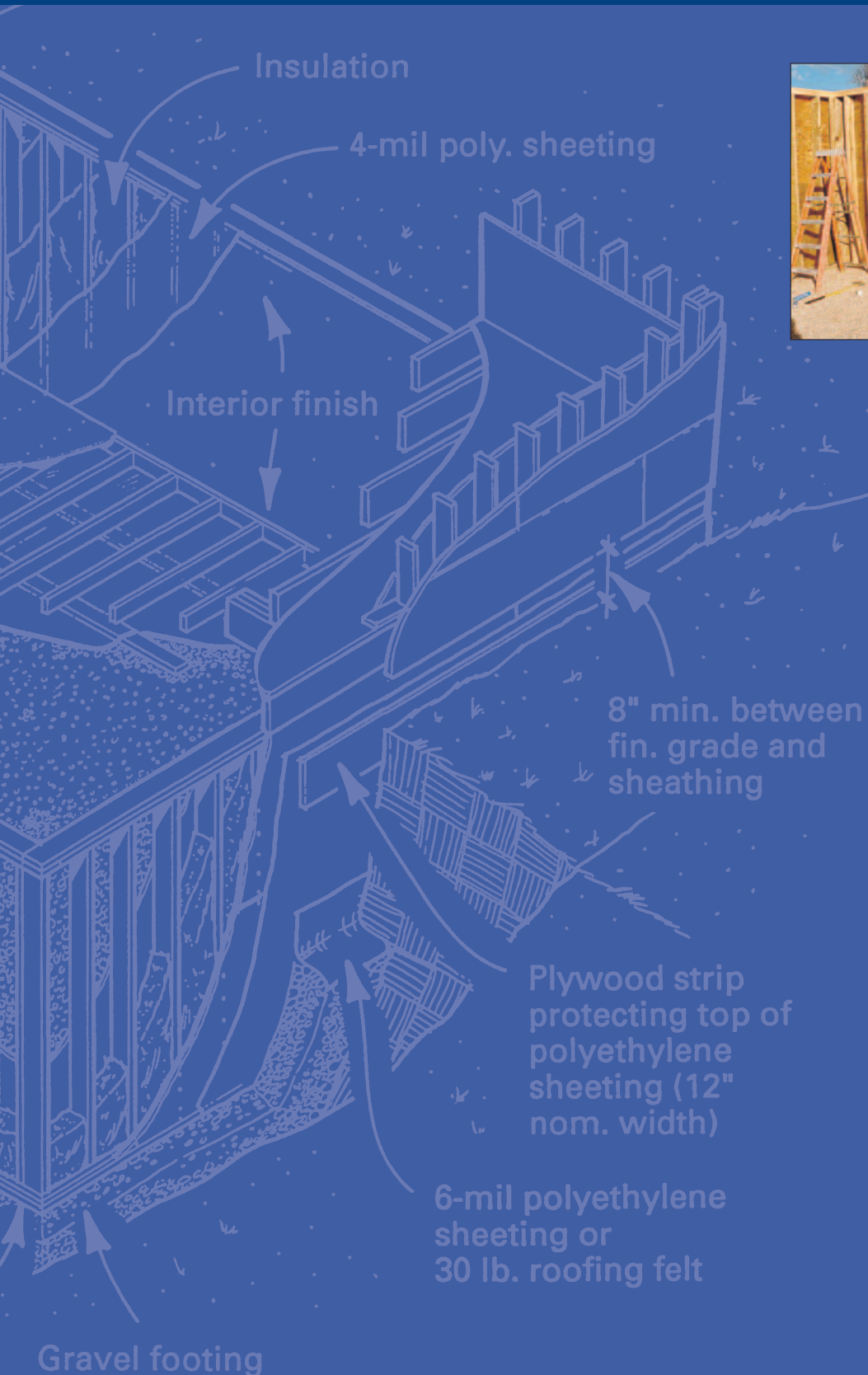




Permanent Wood Foundations

Southern Pine by Design

Design & Construction Guide



INTRODUCTION

The Permanent Wood Foundation (PWF) is an innovative building system that saves builders time and creates comfortable, warm living areas that enhance a home's salability.

Just what exactly is a Permanent Wood Foundation? It's a load-bearing lumber-framed foundation wall sheathed with plywood. All lumber and plywood components in the wood foundation are pressure-treated with preservatives to withstand decay from moisture and insect damage.

The PWF is an engineered foundation construction system. The engineering design analysis was developed jointly by the U.S. Department of Agriculture's Forest Service, the American Forest & Paper Association (AF&PA), and the American Wood Preservers Institute (AWPI), with field evaluations by the National Association of Home Builders Research Foundation, Inc. Additional laboratory and in-ground structural testing has been conducted by APA-the Engineered Wood Association.

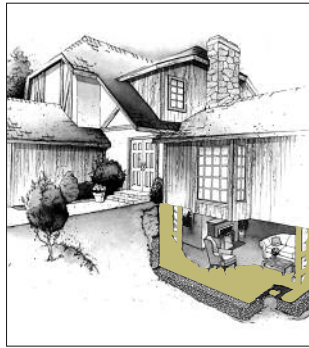
Durability of the system is demonstrated by long-term in-ground tests conducted by the Forest Service. In these tests, pressure-treated wood has withstood severe decay and termite conditions over decades of exposure. PWF walls are designed to resist and distribute earth, wind, seismic loads and stresses that may crack other types of foundations.

The Permanent Wood Foundation is accepted by the major model building codes, by federal agencies, and by lending, home warranty, and fire insurance institutions. And it has been proven by years of success in more than 300,000 homes and other structures throughout the U.S.

This guide describes the features and advantages of Permanent Wood Foundations. And it provides builders and architects with detailed construction tips for a variety of building styles, including both crawl space and full basement foundations.

A PROVEN, PRACTICAL SYSTEM

Permanent Wood Foundations consist of load-bearing walls framed with pressure-treated lumber and sheathed with pressure-treated APA-trademarked plywood (see Figure 1). The walls are designed to withstand backfill and vertical loading. They are supported laterally at the top by the floor system, at the bottom by a cast-in-place slab or pressure-treated wood basement floor, and at the base by backfill and foundation footings of crushed stone,



gravel, coarse sand or poured concrete. The footings distribute the vertical load from the structure to the soil.

The recommendations for foundation sheathing, studs and connections are based on thorough design analysis, developed by experts of the wood products industry and the National Association of Home Builders Research Foundation, Inc. These recommendations provide a quality "engineered" foundation

system that resists backfill and wind or seismic loads. The details are applicable for most common construction applications in a variety of soils.

In larger or more complex buildings, engineering may be necessary because of differing structural requirements. If so, refer to *Permanent Wood Foundation System: Design, Fabrication and Installation Manual*, (DFI Manual), available from the American Forest & Paper Association. It contains complete design data and is the source of some of the tabular materials and many of the details given in this guide.

PWF construction is similar to wood-frame exterior wall construction, with some exceptions. Because PWF walls are used in below-grade applications, all lumber and plywood is pressure-treated with preservatives for decay and termite resistance. Other differences include the use of stainless steel nails, an offset footing plate, and framing anchors to connect foundation studs and floor joists to the top plates of foundation walls in high backfill conditions.

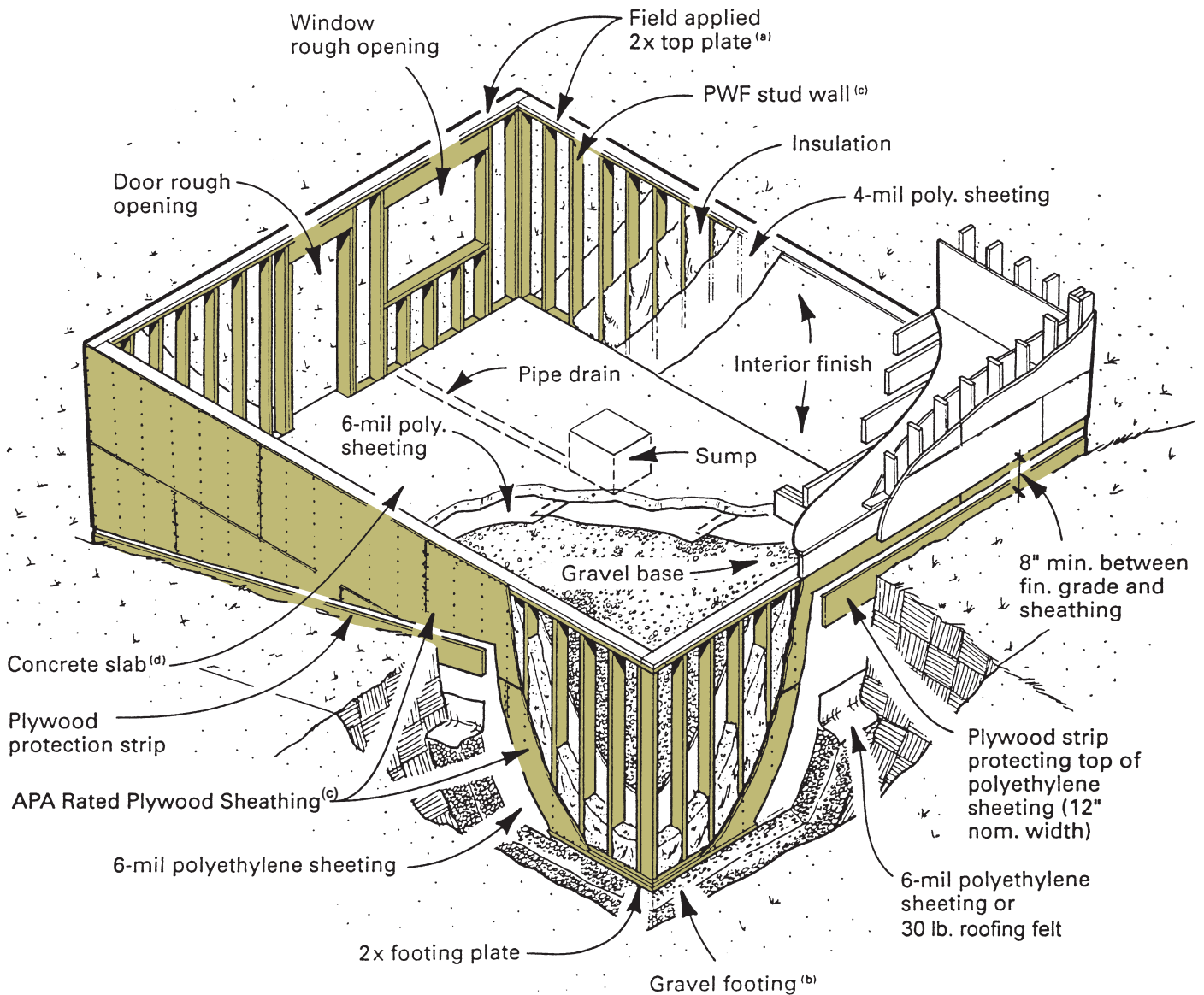
Like conventional wood-frame walls, the wood foundation is adaptable to virtually any design. It fits a variety of floor plans and can be used for both level and sloping sites.

In certain localities where emission of radon gas from the soil or ground water is prevalent, a plastic pipe and tee can be installed through the basement floor for basement-type PWFs. For crawl space PWFs, a perforated plastic pipe can be installed on the ground inside the crawl space, beneath the vapor retarder. In both applications, the pipe is connected to a vent pipe and exhaust fan to depressurize the soil under the basement floor or crawl space vapor retarder, removing radon gas from the soil under and around the building. If a sump is used, the sump cover should be sealed and connected to the vent pipe and exhaust fan to remove radon gas from the sump pit.

FIGURE 1

■ PRESSURE-TREATED
SOUTHERN PINE

*Typical Permanent
Wood Foundation
– Basement Type*



(a) Not required to be treated if exterior finish grade is 8" or more below bottom of plate. Typical for all following details.

(b) See Figure 19 for optional concrete footing detail.

(c) See Appendix III (page 47) for plywood and framing fastener schedules.

(d) For optional treated wood basement floor system details, see Appendix II on page 44.

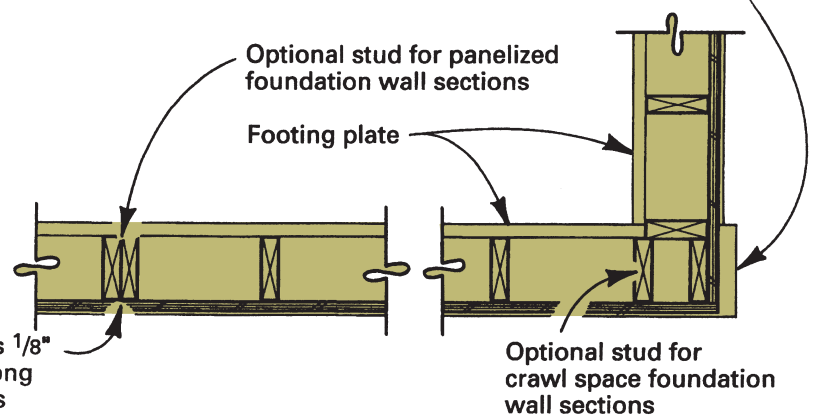
FIGURE 2

Foundation Panel Construction

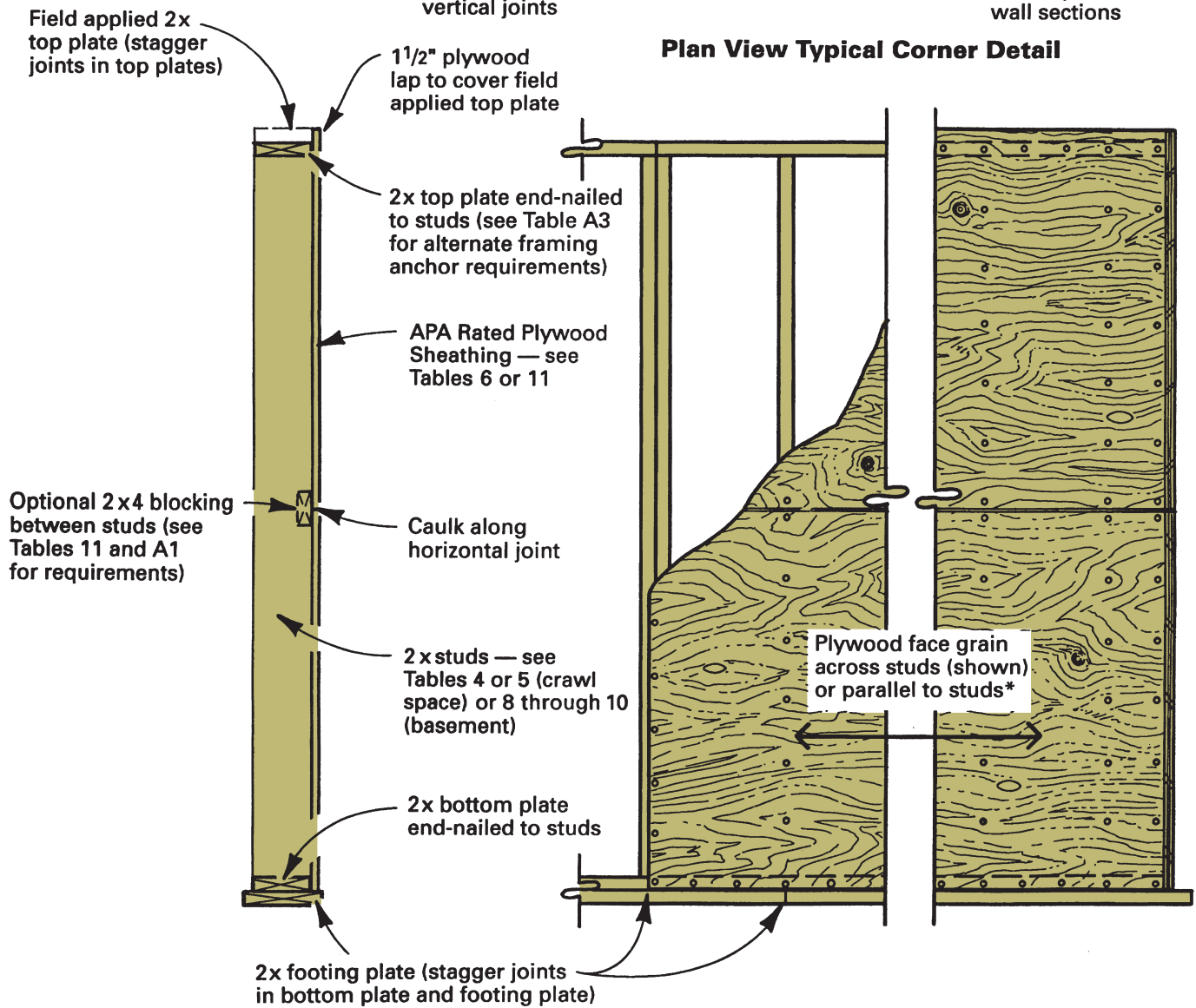
See Tables A1 through A3 for fastener schedules

■ PRESSURE-TREATED SOUTHERN PINE

Footing plate may extend beyond foundation to avoid cutting treated lumber



Plan View Typical Corner Detail



ADVANTAGES

Builders and homebuyers across the country are choosing the Permanent Wood Foundation, and for many good reasons. Here are just a few of the features that are making PWFs increasingly popular:

1. DESIGN FLEXIBILITY – Permanent Wood Foundations can be used in a variety of building types and sizes, including both single and multi-story houses, condominiums and apartments, and for both site-built and manufactured houses. PWFs are suitable for crawl space, split-entry or full-basement designs. Remodeling contractors have found the PWF ideal for room additions, especially where site access is limited.

Offices or other commercial and nonresidential buildings can also be built on a Permanent Wood Foundation. The PWF can be engineered for almost any large or complex building design or to satisfy special site constraints, and can be adapted for a variety of soil conditions, including low-bearing capacity soils, expansive soils or high water tables. The system can even be adapted for such uses as retaining walls and swimming pools.

2. SIMPLIFIED SCHEDULING – The builder's or subcontractor's carpentry crews install the PWF, reducing the need for scheduling other trades. The PWF can be installed under nearly any weather conditions, even below freezing, so the building season is extended. On remote sites, high delivery costs and delays for concrete are eliminated. And there's no need to wait for setting and stripping of concrete forming, or concrete curing.

3. FASTER CONSTRUCTION – The PWF is easily installed by a small crew, often in less than a day, or even in just a few hours. As soon as the foundation is framed and sheathed, construction of floors and walls can proceed. Shorter construction time means savings in interim construction financing — and greater productivity.

4. COMFORTABLE LIVING AREAS – Several features of the PWF make a home attractive to buyers. First — comfort. Permanent Wood Foundation basements have all the livability of above-ground rooms. Wood construction lends a feeling of warmth — not the musty, damp feeling usually associated with masonry basements. And, PWFs incorporate superior drainage features that prevent the moisture problems typical of ordinary foundations. The result is warm, dry below-grade living spaces.

Second, the wood-framed walls of the Permanent Wood Foundation make it easy to install thick, eco-

nomical batt-type insulation. That means less heat loss through the foundation wall and greater long-term savings. The cost of installing insulation is less, too, because the wood-framed walls are already in place.

Consider this comparison: in a concrete foundation, 3/4" or 1-1/2" foam sheathing is typically installed for insulation. This gives an energy rating of R-3 to R-6. In the wood foundation, it's easy to fit 3-1/2" thick insulation between PWF studs, producing an R-11 to R-15 energy rating. If 5-1/2" insulation is installed between 2x6 or 2x8 PWF studs, the energy rating increases to R-19 or R-21.

5. ENERGY EFFICIENCY – The National Energy Policy Act mandates that the basement of a new home must be properly insulated. Several states have already adopted this code; your state may be one of them.

The economical answer to meeting state energy code requirements begins with a Permanent Wood Foundation. Research has found that, to build an 8" basement wall with a insulation value of R-19, concrete costs some 30% more than the PWF; cement block can cost up to 62% more!

Along with energy savings, homeowners enjoy incomparably dry, comfortable living areas. Realtors and lending institutions agree: the PWF works!

6. EASE OF FINISHING – Another advantage of PWFs is ease of finishing. Since nailable studs are already in place, plumbing, wiring and interior wall installation are simplified. Because it's so easy, many PWF homebuyers elect to do the finishing themselves according to their own tastes and imagination — often at less cost.

7. MORE LIVING SPACE – Permanent Wood Foundations can also mean added living space — wood foundation walls need not be as thick as comparable concrete or masonry walls. Less space for insulation, too, because it fits into the cavities of the wood-framed wall — extra furring strips or wall studs aren't necessary.

Finally, PWFs are easy to remodel or modify. Window or door openings can be cut out, or a whole room added. Additional structural engineering may be required for certain remodeling projects.

8. RADON GAS RESISTANCE – PWF Systems have definite advantages for radon gas resistance, both in new construction and retrofits. The gravel layer beneath the basement floor serves as a collection system for soil gas which is easily vented to the outside.

ACCEPTANCES

This publication is the subject of Building Officials & Code Administrators (BOCA) International Evaluation Report 21-53. This report was issued in August of 2001 by the BOCA Evaluation Services, Inc. Copies of the report have been distributed to all BOCA members and subscribers to the Evaluation Service. Additionally, the report is listed on the BOCA-ES website: www.bocai.org, or it may be obtained by contacting the Southern Forest Products Association (504/443-4464).

The PWF is accepted by the following regulatory bodies and underwriting agencies:

MODEL BUILDING CODES

- International Residential Code for One and Two-Family Dwellings. 2000 edition. International Code Council (ICC). Section R402, Figures R403.1(2 & 3), Section R403.2, R404.2-4, Table R404.4(1), Sections R405.2, R406.3, and R602.3(1).
- National Building Code. 1996 edition. Building Officials and Code Administrators International, Inc. (BOCA). Sections 1808.3, 1813.3 and 2311.3.
- Uniform Building Code. 1997 edition. International Conference of Building Officials (ICBO). Section 1810 through 1814.
- Standard Building Code. 1994 and 1997 editions. Southern Building Code Congress International Inc. (SBCCI). Sections 1804.8, 2301.4.6 and 2306.3.
- One and Two-Family Dwelling Code. 1995 edition. Council of American Building Officials (CABO). Sections 402.1, 403.2, Figures 403.1b, 403.1c, Sections 404.3, 405.2, and 406.3.



FEDERAL AGENCIES

- Farmers Home Administration (FmHA)
- Veterans Administration (VA)
- Department of Housing and Urban Development — Federal Housing Administration (HUD/FHA)

The above agencies refer to local, state or model building codes.

LENDING & MORTGAGE INSURANCE INSTITUTIONS

- Mortgage Guaranty Insurance Corporation (MGIC)
- Government National Mortgage Association (GNMA)
- Federal Home Loan Mortgage Corporation (FHLMC)
- Federal National Mortgage Association (FNMA)
- United States League of Savings Associations

Covered in Construction: Principles, Materials and Methods, Section 314 and WF 314.

- Verex Assurance, Inc.

WARRANTY & FIRE INSURANCE INSTITUTIONS

- Home Owners Warranty Corporation (HOW)
Wood foundations must be shop-fabricated and built within the jurisdiction of a building code accepting its use. Other acceptable methods of construction are approved on a case-by-case basis.
- Insurance Services Office (ISO)
No differential in fire insurance rates between wood and conventional foundations.

The PWF is also accepted by many state and local building codes and lending agencies, plus other regional and national warranty corporations accepted by HUD.

A BETTER HOME STARTS WITH A PERMANENT WOOD FOUNDATION

This newly completed research demonstration house in Madison, Wisconsin (on the grounds of the USDA Forest Products Laboratory) opened its doors to public tours in late October, 2001. One of the most-asked-about features of the 2300 square-foot, four-bedroom home is the PWF beneath it. Visitors are amazed not to experience the damp, musty feeling so often associated with masonry basements. Detailed cutaways of a wall and floor section (C) reveal the structural wood and other components at work to create a positive drainage system, pulling moisture away from the house.

For this home, the PWF wall sections were prefabricated at the Windsor Homes plant in Madison (A), assembled in 8x8-foot panels using 2x6 treated Southern Pine studs and 2x8 plates. Installation was completed in the middle of winter (B).

This unique research demonstration house (D) was designed to study moisture-resistant construction techniques and proper building practices. For additional information, visit www.builddabeterhome.org. A tour of the home can be arranged by contacting Karen Martinson at FPL, 608/231-9450 (e-mail: klmarti3@facstaff.wisc.edu).



SITE CONSIDERATIONS

SOIL CONDITIONS

The type of soil and general grading conditions at the building site are factors in determining foundation construction details such as footing design, backfill and drainage provisions.

Soils are classified by their composition and how they drain. Table 1 lists common soil types and their properties. Soil classifications for most areas are

listed in the standard series of soil surveys published by the U.S. Department of Agriculture's Soil Conservation Service.

PWFs may be built in Group I, II, or III soils. In poorly drained Group III soils, granular fill under the slab for basement-type foundations must be at least 6" deep, as opposed to the 4" minimum for Group I

TABLE 1 – TYPES OF SOILS AND RELATED DESIGN PROPERTIES

Soil Group	Unified Soil Classification Symbol	Soil Description	Allowable Bearing in Pounds Per Square Foot with Medium Compaction or Stiffness ¹	Drainage Characteristics ²	Frost Heave Potential	Volume Change Potential Expansion ³
Group I <i>Excellent</i>	GS	Well-graded gravels, gravel-sand mixtures, little or no fines.	8000	Good	Low	Low
	GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.	8000	Good	Low	Low
	SW	Well-graded sands, gravelly sands, little or no fines.	6000	Good	Low	Low
	SP	Poorly graded sands or gravelly sands, little or no fines.	5000	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures.	4000	Medium	Medium	Low
	SM	Silty sand, sand-silt mixtures.	4000	Medium	Medium	Low
Group II <i>Fair to Good</i>	GC	Clayey gravels, gravel-sand-clay mixtures.	4000	Medium	Medium	Low
	SC	Clayey sands, sand-clay mixture.	4000	Medium	Medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	2000	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	2000	Medium	Medium	Medium ⁴
Group III <i>Poor</i>	CH	Inorganic clays of high plasticity, fat clays.	2000	Poor	Medium	High ⁴
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	2000	Poor	High	High
Group IV <i>Unsatisfactory</i>	OL	Organic silts and organic silty clays of low plasticity.	400	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts.	–0–	Unsatisfactory	Medium	High
	Pt	Peat and other highly organic soils.	–0–	Unsatisfactory	Medium	High

1 Allowable bearing value may be increased 25 percent for very compact, coarse grained gravelly or sandy soils or very stiff fine-grained clayey or silty soils.

Allowable bearing value shall be decreased 25 percent for loose, coarse-grained gravelly or sandy soils, or soft, fine-grained clayey or silty soils.

2 The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 to 4 inches per hour, and poor is less than 2 inches per hour.

3 For expansive soils, contact local soils engineer for verification of design assumptions.

4 Dangerous expansion might occur if these soil types are dry but subject to future wetting.

and II soils. In such soil conditions, it may be more practical to build an above-grade crawl space foundation/floor system (see Figure 3), especially for sites having a high water table, or where extreme amounts of rain often fall in short periods of time. Regardless of soil type, above-grade crawl space foundation/floor systems have the cost benefit of minimum excavation and backfill.

Group IV soils are generally unsatisfactory for wood foundations, unless special measures are taken. For building sites in regions where expansive clay soils in Groups II, III or IV occur, a licensed soils engineer should be consulted to determine modifications required for foundation footings, drainage, soil moisture control, and backfill around the foundation. In such cases, special design considerations and construction details may be needed to avoid soil expansion or shrinkage which might otherwise affect foundation and floor performance.

For basement-type foundations, a sump, draining to daylight or into a storm sewer or other storm water drainage system, is recommended for all soil groups.

In addition, for all types of foundations in all soil groups, the ground surface around the foundation should be graded to slope 1/2" per foot away from the structure. The backfill should be free of organic material, voids or chunks of clay, and it should be compacted and no more permeable than the surrounding soil.

SITE PREPARATION

Site clearing and excavation methods for the Permanent Wood Foundation are the same as for conventional foundation systems. Organic materials, including tree stumps or other vegetation, should be removed and topsoil separated from excavated earth, which may be used later for backfilling or grading.

After clearing the site, it's wise to use a plot plan to locate foundation footings and trenches for plumbing, sewer, gas and electrical lines and drainage trenches. Excavation for foundation footings, plumbing and other services and drainage trenches must

FIGURE 3

Above-Grade Crawl Space Foundation for High Water Table or Soil Drainage Problems

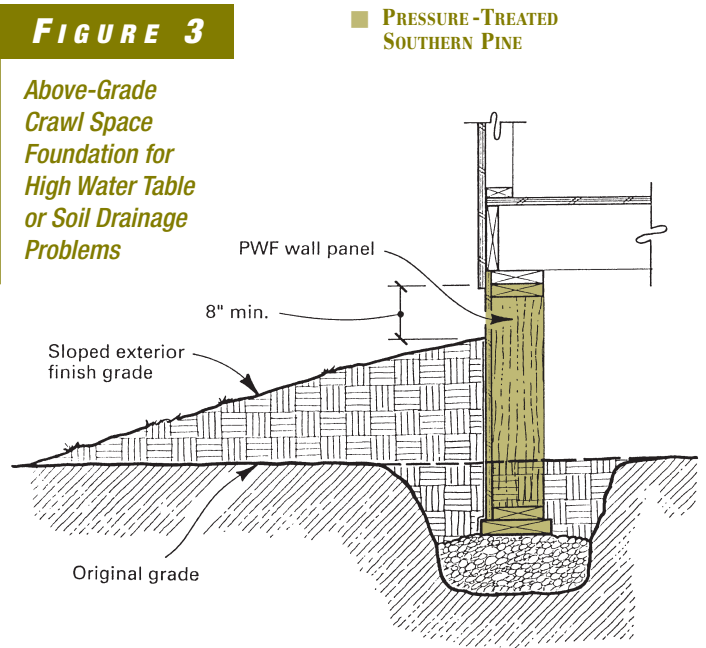
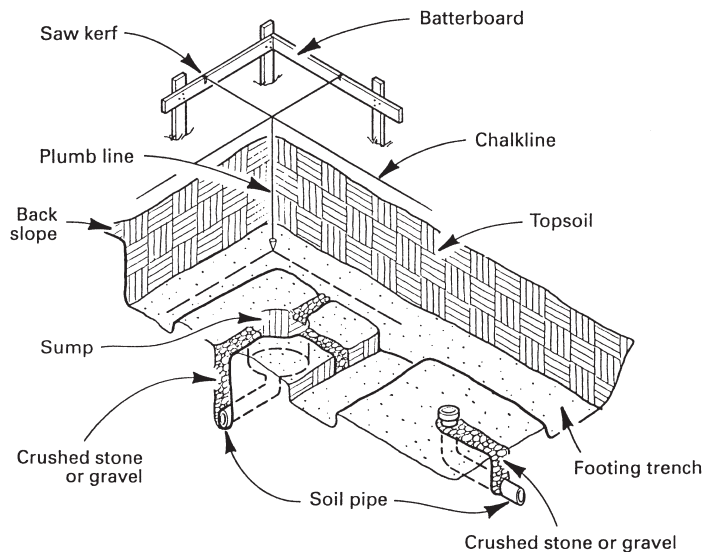


FIGURE 4

Typical Excavation for Footings and Under-Floor Tile, Pipes, Conduit and Sump



be completed before soil treatment for termite protection (if required); otherwise, retreatment is necessary.

After utility trenches are dug to the desired level, they can be lined with fine gravel or sand before pipes and conduit are set in place. Then the trenches are filled the rest of the way with gravel, coarse sand or crushed rock (see Figure 4).

FOOTINGS AND BACKFILL

Granular materials are recommended for footings under foundation walls, for fill under the basement slab or treated wood basement floor, and for a portion of the backfill to provide an optimum drainage system to keep the underfloor area and foundation walls in a dry condition. The granular material may be crushed stone, gravel or sand, and must be clean and free of silt, clay and organic material. The size limitations are:

Maximum of 1/2" for crushed stone

Maximum of 3/4" for gravel

Minimum of 1/16" for sand

Alternatively, continuous poured concrete may be used for the footings beneath foundation walls. If a concrete footing is used, it should be placed on gravel to maintain continuity of the drainage system, otherwise drains through the concrete footing must be provided.

As with all types of foundations, footings need to be placed on undisturbed soil and the footing excavation should extend below the frost line. Footing trench depth and width, as with conventional systems, depend on the loads to be carried by the foundation.

Excavations must be wide and deep enough into undisturbed soil so that the footings will be centered under the foundation walls. The use of granular or concrete footings distribute vertical loads from the structure and foundation walls to the soil. Footings are required under perimeter and interior load-bearing walls.

SITE DRAINAGE

Proper site drainage is an important feature in keeping any type of foundation dry and trouble-free. A superior drainage system has been developed for



the wood foundation to keep crawl spaces and basements dry under virtually any condition. The granular footings and backfill are key elements in the PWF drainage system. They provide an unobstructed path for the water to flow away from the foundation, or into a sump for basement houses. This prevents a buildup of pressure against the foundation and helps to avoid leaks.

Following are several methods of providing drainage around excavated foundations:

In permeable Group I soils, such as gravel, sand, silty gravels and gravel-silt-sand mixtures with a percolation rate of more than 4" per hour, the gravel footing of the Permanent Wood Foundation provides the drainage trench for sites with good surface water runoff.

For continuous concrete footings, place gravel under and around the outside of the footing, at least 12" wide by 12" deep. Water will collect in the gravel beneath the footing, and then can be drained away from the foundation. Cover the gravel with 6-mil polyethylene sheeting or wrap gravel with water permeable filter fabric to prevent soil from washing into the footing.

In Group II soils such as gravel/sand/clay mixtures, clay, gravels or sands, inorganic silts and fine sand with medium to poor percolation characteristics, dig a trench sloping away from the gravel foundation footing. On a sloping site, it may be practical to dig the drainage trench to daylight, where the site slope intersects the drainage trench (see Figure 5). Place about 6" of gravel in the trench and cover with 6-mil polyethylene sheeting. As an alternative, drain tile or soil pipe could be placed into the trench from the gravel footing to the point where the trench emerges.

Foundation footings and basement sump (when used) should be drained to a storm sewer, drainage swale or to daylight. On level sites, or on sites where direct drainage to daylight or a storm sewer is otherwise impractical, it may be necessary to dig drywells or sump pits at several locations around the outside of the foundation (see Figure 6). For optimum effectiveness, rely on drywells only in areas of well-drained Group I soils with high sand or gravel content. The bottom of the drywell should project into undisturbed, porous soil at a level above the highest seasonal ground water table.

The sump pit should be at least 2 feet deeper than the base of the gravel footing, and about 3 feet in diameter. The top of the sump should be at a lower elevation than the footing. Connect the sump pit to the footing either with a gravel filled trench or with drainage tile or soil pipe.

In medium-drained soils, a gravel-filled sump should be sufficient to provide proper drainage. In poorly drained soils, either provide drainage from the sump pit to a storm sewer or, in extreme drainage problem cases, install a sump pump inside prefabricated sump tile (see Figure 6).

For crawl space foundations, when the interior ground level is below outside finish grade, granular drainage trenches or drain pipes are recommended for draining footings or perimeter drains by gravity to daylight, storm sewers or other approved storm water drainage system.

On sites where proper drainage may be expensive or troublesome, consider using an above-grade foundation/floor system and make sure the finish grade slopes away from the foundation.

In rainy climates, provide for drainage inside the foundation. This can be done by grading to a low spot on the ground inside, such that the underfloor area will drain to it.

After the building is complete, make sure that the foundation and underfloor areas remain dry by providing for adequate drainage of storm water. Most important is the use of gutters, downspouts and splash blocks or drainpipe to direct water runoff away from the building. Also slope adjacent porches or patios to drain away from the building.

FIGURE 5

Footing Drainage Trench to Daylight

■ PRESSURE-TREATED SOUTHERN PINE

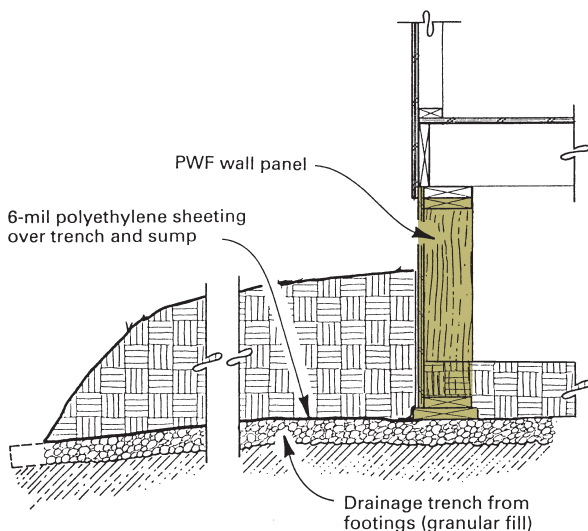
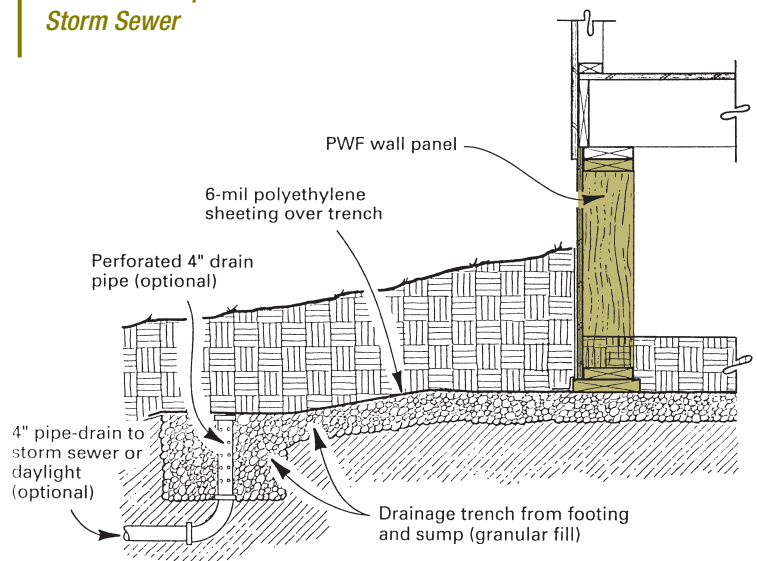


FIGURE 6

Footing Drainage Trench to Sump or Storm Sewer



MATERIAL SPECIFICATIONS

PLYWOOD

Plywood recommended for the PWF system is all-veneer APA-Rated plywood sheathing, Exposure 1 marked APA Series V-600 or Exterior marked APA Series V-611, and produced according to U.S. Product Standards PS1, PS2 or APA Standard PRP-108*.

The APA trademarks signifies that the manufacturer is committed to APA's rigorous program of quality inspection and testing, and that panel quality is subject to verification through APA audit. Always insist that the plywood you use or specify for the Permanent Wood Foundation bears the trademark APA—The Engineered Wood Association.



TYPICAL APA GRADE STAMPS SUITABLE FOR PWF CONSTRUCTION



LUMBER

Southern Pine is the preferred lumber species for building the Permanent Wood Foundation. Southern Pine lumber is readily available in a wide range of grades and sizes. In structural terms, it is one of the strongest softwoods.

Quality Southern Pine lumber is graded in accordance with the grading rules of the Southern Pine Inspection Bureau (SPIB). SPIB, Timber Products

Inspection, Inc. (TP), Renewable Resource Associates, Inc. (RRA) and other organizations** are accredited by the American Lumber Standard Committee, Inc. (ALSC) to inspect and grade mark Southern Pine lumber in accordance with these grading rules.

An authorized grade mark on each piece of Southern Pine lumber assures the buyer that the product specified is being received. The inspection agency is identified (SPIB, TP, or RRA among others**) along with the grade of the piece, its moisture content, and a mill number identifying the manufacturer. SFPA members can include the association's logo in the grade mark, but this logo is optional.

PRESERVATIVE TREATMENT

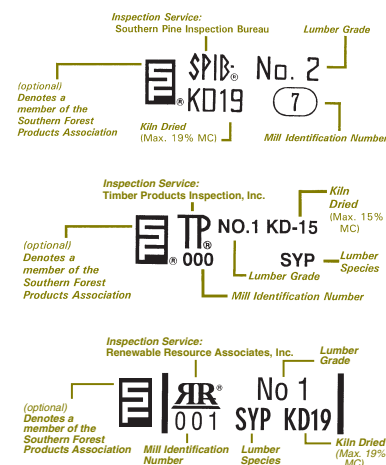
Southern Pine is also the preferred species when pressure treatment with preservatives is required, because of its ease of treatability. The unique cellular structure of Southern Pine permits deep, uniform penetration of preservatives, rendering the wood useless as a food source for fungi, termites and microorganisms.

Most wood species do not readily accept preservatives, and must first be "incised" or perforated with a series of small slits along the grain of the wood's surface. Southern Pine is one of the few wood species that does *not* require incising to meet American Wood Preservers' Association (AWPA) Standards.

The waterborne preservative most commonly used to treat PWF material is known as CCA, or Chromated Copper Arsenate. This type of chemical treatment is clean, odorless and paintable, plus it is EPA-registered for both interior and exterior use without a sealer. For complete information about CCA-treated Southern Pine, the treating process, applicable AWP Standards and other details, refer to the booklet *Pressure-Treated Southern Pine*, available from the Southern Pine Council.

AWPA has developed different levels of preservative retention in treated lumber, based on its intended use.

Retention levels refer to the amount of preservative that remains in the cell structure after the pressure process is completed. Retentions are expressed in pounds of preservative per cubic foot of wood.

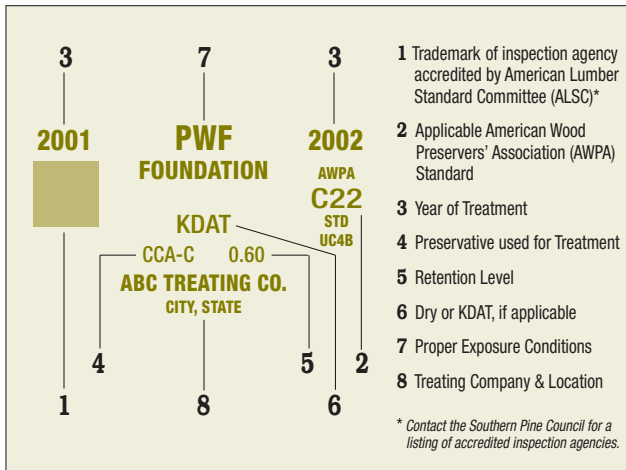


Typical Certified Lumber Grade Marks

** NOTE: Other agencies are accredited by ALSC to inspect and grade all or selected Southern Pine products according to SPIB Grading Rules, including: California Lumber Inspection Service (CLIS); Northeastern Lumber Manufacturers Association (NELMA); West Coast Lumber Inspection Bureau (WCLIB); and Western Wood Products Association (WWPA).

*Use of plywood marked PS2 or PRP-108 should be confirmed per local code requirements.

TYPICAL QUALITY MARK FOR TREATED PWF LUMBER



For CCA-treated lumber and plywood to be used in the PWF, AWPA Standard C22 (Use Category 4B) states that the material must have a minimum preservative retention level of 0.60 pounds of preservative per cubic foot of wood.

All CCA-treated lumber and plywood used in a PWF should also be identified by a quality mark of an ALSC-accredited inspection agency. The quality mark may be an end-tag attached to the lumber or an ink stamp. An example of the treating information that should be present is shown below.

The presence of *both* a lumber grade and a quality mark indicates that the producer of the product subscribes to rigorous quality-control standards established by the industry.

After treatment, the wood is redried to a moisture content of 18% or less for plywood, and 19% or less for lumber. Preservative-treated wood retains all of its stiffness and strength, and has the added value of permanent protection against decay and termite damage. If possible, lumber should be cut to the desired lengths before treatment.*

Studs cut after pressure treating need not be field treated if the cut ends are at least 8" above the backfill. Footing plates may be extended past the corner of the foundation to minimize end cutting and field treating.

*Field application of minimum 2% solution copper naphthenate recommended for any necessary field cuts.

**In some jurisdictions, required throughout the foundation.

FASTENERS

Fasteners used in foundations must be corrosion resistant. Types 304 or 316 stainless steel nails are recommended below grade for attaching treated plywood to treated lumber.** Specific fastener schedules are shown in Appendix III, Tables A1 through A6. Refer to page 47.

For most above-grade uses, plywood may be attached with hot-dipped or hot-tumbled galvanized nails, or stainless steel, silicon bronze, or copper fasteners.

Lumber-to-lumber fasteners above grade can generally be hot-dipped galvanized nails. Stainless steel type 304 or 316 nails are generally required below grade, for all knee wall assemblies, and in some jurisdictions throughout the foundation.

TERMITE PROTECTION

Required minimum clearances between the ground surface and any untreated wood in the building are listed in Table 2.

With less than 18" of clearance under floor framing or less than 12" under floor girders, the shallow underfloor space is generally inaccessible for inspection. In

Outside Grade	
To framing	8 inches
To wood siding	6 inches
Inside Grade (crawl space)	
To floor joists	18 inches
To floor girder	12 inches

such cases any wood that is at or below the level of the floor sheathing (including the floor sheathing itself, the floor framing, girders, posts, perimeter joists and blocking, as well as the PWF) must be pressure treated.

If treated plywood and lumber are used in floor construction, they should be treated in accordance with applicable American Wood Preservers Association Standards. Pressure-treated wood must be certified and marked indicating compliance with these treating requirements. All such treated wood should be dried to a moisture content of 19% or less (18% for plywood) after treatment, to minimize subsequent shrinkage.

Proper ventilation and use of a vapor retarder on the ground in crawl spaces will help prevent the moist conditions that subterranean and dampwood

termites favor. The minimum ventilation requirements are based on the ratio of the net free ventilation area to the floor area to be ventilated. The minimum code required ratio applicable to crawl spaces is 1:150.

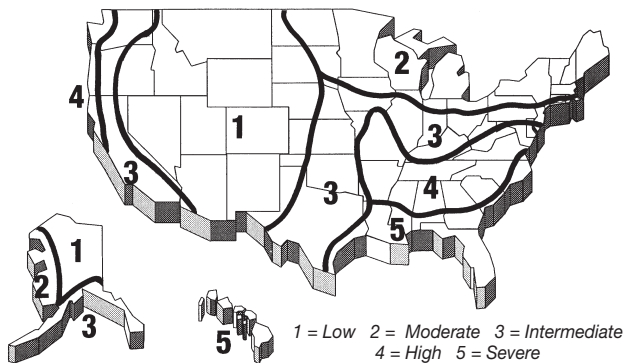
In termite regions, treat the soil along the outside and inside of granular footings and backfill for foundation walls, under basement floors or slabs, and at other points of ground contact.

If the soil inside the crawl space is not treated, pressure-treated wood is recommended for the subfloor sheathing, floor framing and supports. If soil treatment is not used in termite regions, the foundation walls and underside of the floor structure should be inspected periodically for evidence of termite infestation, especially if untreated materials are used in floor construction.

For more information on termite protection, refer to APA Technical Note K830, *Termite Protection for Wood-Framed Construction*. Contact SPC, see page 49.

FIGURE 7

Wood Deterioration Zones



SOURCE: AWPA Book of Standards, 1997 Edition.

FOUNDATION WALL CONSTRUCTION

A typical PWF foundation wall panel is framed with 2" dimension lumber, and can be fabricated in sections of any convenient length (see Figure 2). Height will depend on whether it is for crawl space or basement foundations. Plywood may be oriented with the face grain horizontal or vertical (APA Structural I Rated Sheathing). Blocking between studs is

not required, except as noted in the following pages or where foundation walls serve as shear walls.

The treated footing plate may be placed on the granular footings, leveled and staked into position before erecting the foundation walls. Alternatively, the footing plate may be pre-attached to the bottom wall plate before foundation installation. The end joints in the footing plates must be staggered at least one stud space from the end joints in the bottom plate of the wall section, as shown in Figure 2.

Corners are framed in the same manner as panelized wood-frame construction. The end stud of the corner panel is set back the stud depth plus the thickness of the plywood sheathing, as illustrated in Figure 2. Wall sections are constructed so that all vertical joints between plywood sheathing panels are backed by a stud.

In full basements, all plywood joints are sealed their full length with caulking. This is applied before installing the adjoining panels.

Squareness of construction is extremely important. The framed panels should be checked for squareness by measuring diagonals. Diagonal measurements should not differ by more than 1/8" for 4x8-foot units (proportionately more or less for other sizes).

After the foundation wall sections are installed, an untreated top wall plate is nailed in place, with end joints staggered at least one stud space for continuity. The next step is to install the floor framing. Methods of attachment are shown in Tables A2 through A5 in Appendix III. Note requirements for blocking between floor joists in the outer joist space along foundation end walls for deep backfill conditions.

Nailed connections are important in the PWF, particularly the stud-to-plate and plate-to-floor framing connections at the top plate, where they provide the support necessary to withstand lateral soil pressure.

The entire floor system, including blocking and plywood subflooring, must be in place before backfilling.

In basement construction, the concrete basement slab must also be poured, or the treated wood basement floor installed before backfilling.

In crawl space construction, backfill around the interior base of the foundation wall and install the floor system. Once the floor is in place, begin backfilling against the exterior side of the foundation.

MOISTURE BARRIER AND SEALING

A vital part of the Permanent Wood Foundation is moisture control. Caulking the panel joints and applying polyethylene sheeting over the foundation — two steps not required in crawlspace construction — are important in providing water shed in basement construction. Seal all plywood joints *for their full length* with a high-performance acrylic latex or polyurethane caulk.

Six-mil polyethylene sheeting covers the below-grade portions of basement foundation walls. This directs moisture to the gravel fill and footings so it can drain without causing pressure against the wall. The polyethylene sheeting may be installed over the foundation walls any time before backfilling. Spot-bond the polyethylene to the plywood with a butyl-rubber adhesive/caulk. Lap vertical joints in the sheet 6" and seal them with the adhesive/caulk. The film hangs freely down the wall and is protected from exposure to sunlight and weathering at the top by a treated plywood nailing strip at least 12" wide.

PLUMBING, HVAC AND ELECTRICAL

Wherever possible, route plumbing, wiring, and heating or air conditioning ducts through interior partition walls or spaces. If necessary, they may be installed in the vertical stud spaces of PWF walls. However, studs, plates, structural blocking, and framing anchors between foundation wall and floor framing should not be cut or removed. In some cases, it may be necessary to provide a furred wall or ceiling chase adjacent to PWF walls for routing plumbing and ducts.



Electrical wiring in PWF walls may be routed vertically within the stud spaces to outlet boxes or switches, and pass through drilled holes in the top plates of the foundation wall for routing through floor joist spaces to other locations.

INSULATION

For best thermal performance and efficiency, fill PWF wall cavities with insulation. When installing insulation between studs in the below-grade portion of basement foundation walls, provide a space of at least 2" between the end of the insulation and the bottom plate.

If using less than full-depth insulation, push the insulation against the exterior foundation sheathing to avoid circulation of cold air and condensation on the sheathing.

After the basement walls are plumbed, wired, and insulated, staple 4-mil polyethylene sheeting across the interior surface of the PWF studs and extending down to the bottom of the wall. The polyethylene serves as a vapor retarder on the warm side of the insulation. Gypsum wallboard or other paneling may then be installed as an interior finish.

In regions where frozen soil against the foundation may cause structural problems resulting from excessive lateral loads, do not install the insulation more than 24" below the outside grade. Backfill the foundation with granular material. These steps result in some heat loss, but prevent ice from building up against the wall.

In crawl space foundation/floor construction, unfaced mineral fiber or fiberglass batt insulation is typically installed under the floor between the joists. When closeable foundation vents are used, insulation may be installed against the perimeter floor joists and over the inner faces of the foundation studs and plates of the foundation wall. Insulation may also be placed on the ground around the inside perimeter of the foundation for greater energy efficiency. Separate the insulation from the earth by placing a vapor retarder on the ground in the crawl space.

Foam plastic insulation also may be used for foundation insulation in accordance with model building code provisions or special proprietary product acceptances.

PWF INSTALLATION

Installation of a Permanent Wood Foundation is speedy. On a prepared site, a PWF can typically be installed in less than one day, but it's not unusual to see one installed in just hours. Here's the installation sequence:

1 The building site is prepared. Topsoil is removed, all excavation and trenching completed. Utility and drainage lines have been installed.

2 A minimum of 4" of gravel, coarse sand, or crushed rock is laid as a base for the concrete slab or the wood floor to be installed later. Thickness of gravel under footings is relative to their width.

3 Gravel is leveled, extending several inches beyond where treated wood footing plates will rest. The gravel under the wood footing plates performs the same function as a conventional concrete spread footing, receiving and distributing loads from foundation walls.

4 Restaking the house is next, after drainage system and gravel footing installation.

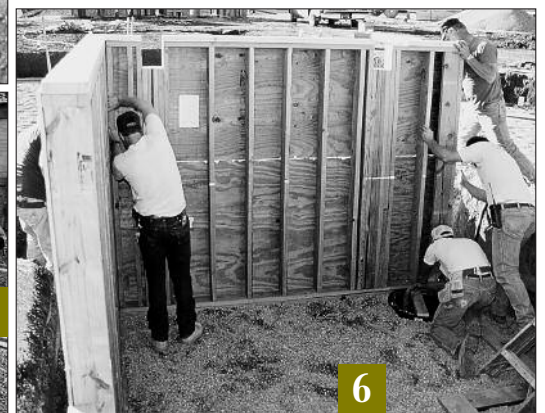
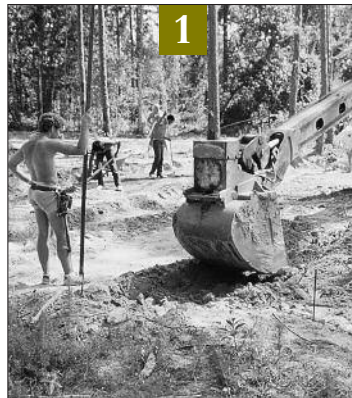
5 Foundation sections can be built at the jobsite, or be prefabricated in panelized sections for accurate and rapid installation. Each section is composed of a footing plate, bottom plate, wood studs, plywood, and single top plate. Here, prefabricated sections are delivered ready for installation.

6 The first section goes up. 8' x 8' panels can be easily set without mechanical assistance. It is recommended that the first two panels installed be located at a corner, because a corner is self-bracing. Check the level of first sections.

7 Caulking is applied between plywood edges of adjoining foundation sections. In full-basement construction, the plywood joints must be sealed full-length with caulking compound. Caulking is not required in crawl space construction.

8 Additional panels of the foundation are attached. Using these preframed sections, windows and door openings are already cut and framed, reducing onsite labor costs.

9 Bracing supports foundation panels while additional sections are installed.





10



11



12



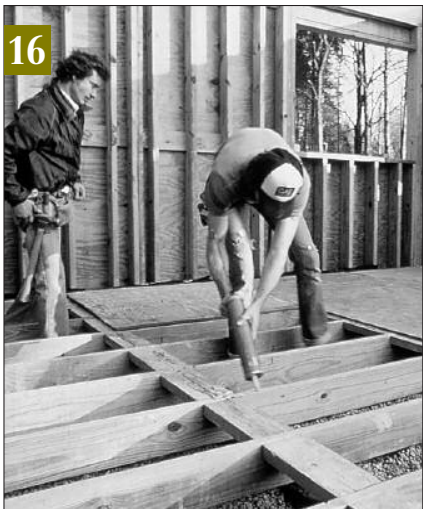
13



14



15



16



17

10 Remaining sections of foundation walls are erected. Extended footing plate automatically offsets wall section joints.

11 Panels are plumbed and aligned. When an accurate line has been established, sections can be shifted inward or outward as needed from the line of reference.

12 Stakes along the footing plate keep the panels from sliding until permanent attachment of all sections is completed.

13 The last section is installed. Once all the foundation wall sections are in place, the entire structure is rechecked to be level and square.

14 The second top plate (typically untreated lumber) is attached. Top plate joints are staggered so that they do not fall directly over joints between foundation wall sections. At corners, joints in the double top plates overlap as in conventional wall construction.

15 Prior to backfilling, 6-mil polyethylene sheathing is attached at the grade line and is draped over the portion of the foundation wall that will be below grade. The top edge is protected with a treated wood strip that is caulked. This strip is a guide for backfilling.

16 Installation of a treated wood floor will optimize the comfort of below-ground living areas.

17 Backfilling takes place after the basement floor is poured and cured, and the first floor framing and floor sheathing are installed. These steps give the PWF lateral restraint for backfill loads. To avoid excessive deflection, backfill in layers of 6" to 8" and tamp to compact. Avoid operating heavy equipment near walls during backfilling.

In Group I soils, the first 12" or more of backfill is the same material as used for footings. For Group II and III soils, backfill with the same materials as footings, for half the height of the backfill. This portion of the fill is covered with strips of 30-pound asphalt paper or 6-mil polyethylene to permit water seepage, yet prevent infiltration of fine soils. Verify that no polyethylene sheathing is exposed below the grade strip.

CRAWL SPACE FOUNDATIONS

The PWF adapts easily to almost any building configuration and for either level or sloping sites. The design details shown in Figure 8 illustrate the simplicity of the PWF crawl space foundation wall in conventional construction.

FOOTINGS

Footing plate size is determined by the vertical load from the structure on the foundation wall, and the size of the PWF studs (see Table 3).

Granular footings are twice the width of the bottom plate, and the depth should be at least 3/4 of the width of the footer plate. Footings for residential construction are typically 4 to 7" deep and 11 to 19" wide. For sloping sites, foundation footings may be stepped using details similar to those shown in Figure 27.

Crawl space PWFs may also be placed on a continuous poured concrete footing, providing the top bearing surface of the footing is carefully leveled and screeded, as shown in Figure 9.

In cold climates with deep frost penetration, granular footings can be trenched deeper to below the frost line as shown in Figure 10.

Alternatively, a deeper "frost wall" foundation can be placed on a normal-sized granular footing with its base below the frost line. In this case, granular backfill should be placed along the foundation walls to prevent frozen earth from "bonding" to the foundation wall sheathing.

FRAMING AND SHEATHING

The size and spacing of PWF stud wall framing members for one and two-story buildings up to 36' wide with crawl space foundations can be selected from Tables 4 or 5. Sizes listed in these tables assume that the crawl space foundation wall itself will be no higher than 4 feet, with a maximum differential backfill height (outside vs. inside grade) of 32 1/2".

Minimum plywood thicknesses for crawl space foundation wall sheathing are shown in Table 6.

Treated plywood foundation wall sheathing recommended for the PWF is all-veneer plywood APA

RATED SHEATHING, marked PS1, PS2* or APA Standard PRP-108, and APA Series V-600 for Exposure 1 or APA Series V-611 for Exterior panels. If appearance is a factor, use APA A-C Exterior, B-C Exterior, C-C Plugged Exterior, MDO Exterior or ungrooved textured APA 303 Rated Siding Group 1 plywood, marked PS1 or APA Standard PRP-108, and APA Series V-611. These grades may also be treated for PWF sheathing to match or complement the siding on the upper stories, or may be applied untreated over the PWF plywood sheathing. Plywood or other wood siding applied 6" or more above grade does not have to be pressure-treated.

FLOOR CONSTRUCTION

Crawl space floor framing with PWF is basically the same as conventional crawl space wood floor construction, with a minimum clearance of 18" below the bottom of floor joists (12" below supporting floor girders). The floor may be framed with joists set on the sill plate, or open-webbed wood floor trusses or structural I-joists may be used.

Crawl space foundation/floor systems can be built to achieve a low-profile appearance, similar to on-grade concrete slab floor construction (see Figure 11). The crawl space area inside the foundation is excavated below existing grade. Ideally, the volume of excavated soil should balance the backfill requirements outside the foundation, with the backfill sloped to provide water drainage for at least six feet or more from the foundation. After the crawl space foundation is completed, floor joists are placed inside the foundation. The top surface of the joists are even with the top plate of the treated wood foundation, and joists are supported either by framing hangers from the top of the foundation, or on a ledger inside the foundation. Since the 18" minimum crawl space clearance is maintained, untreated floor framing and floor sheathing can be used.

Interior supports for floor framing may be posts and girder beams shown in Figure 12, or unsheathed treated plywood bearing walls shown in Figure 13. Beam pocket details for floor support girders are shown in Figure 14 and Table 7.

*Use of plywood marked PS2 or PRP-108 should be confirmed per local code requirements.

FIGURE 8

Crawl Space Foundation

■ PRESSURE-TREATED SOUTHERN PINE

h_i (in.)	Max. h_o (in.)
6	17
8	23
10	28
12	33
14	37

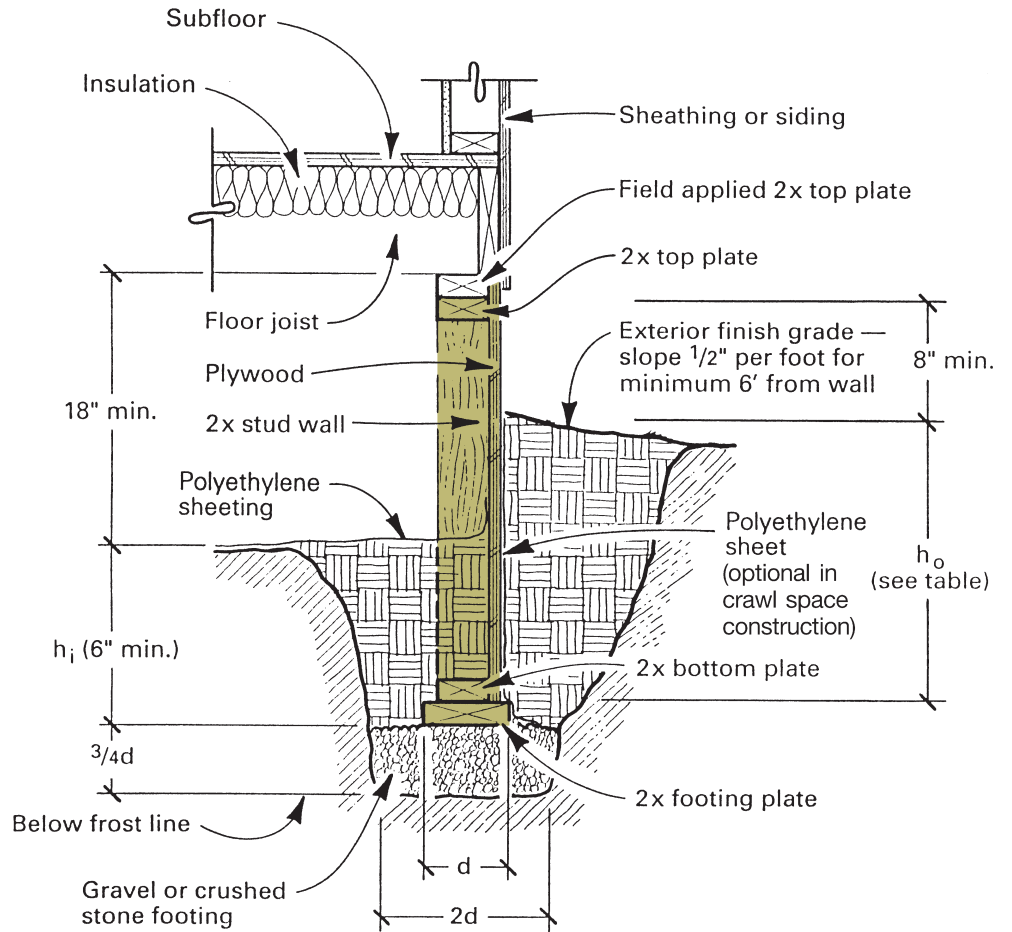


FIGURE 9

Crawl Space Foundation on Concrete Footing

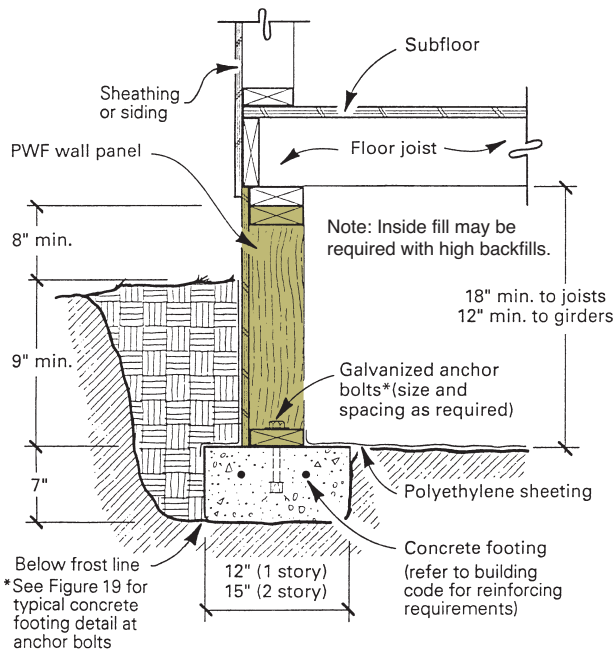


FIGURE 10

Deep Gravel Footing for PWF

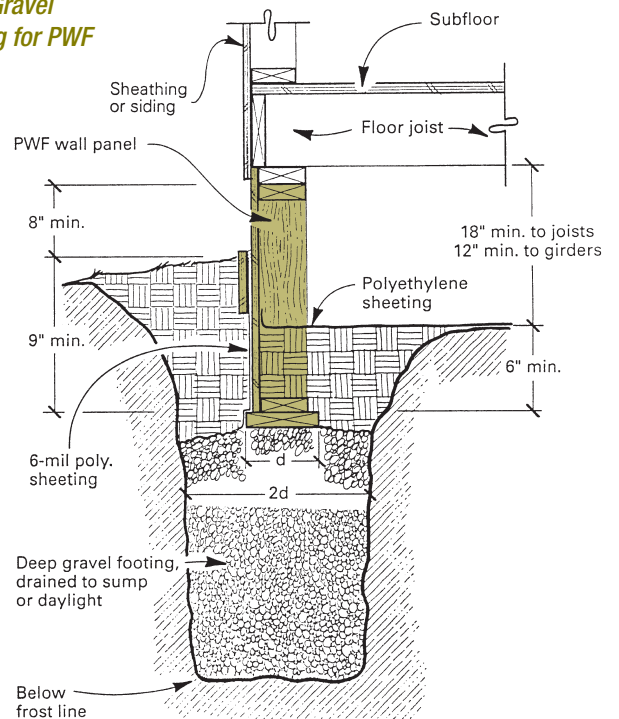


TABLE 3 – FOOTING PLATES, MINIMUM SIZE^{1, 2}

House width (feet)	Roof – 40 psf live; 10 psf dead Ceiling – 10 psf 1st Floor – 50 psf live and dead 2nd floor – 50 psf live and dead		Roof – 30 psf live; 10 psf dead Ceiling – 10 psf 1st Floor – 50 psf live and dead 2nd floor – 50 psf live and dead	
	2 stories	1 story	2 stories	1 story
36	2 x 10	2 x 10	2 x 10	2 x 8
32	2 x 10	2 x 8	2 x 10	2 x 8
28	2 x 10	2 x 8	2 x 8	2 x 6
24	2 x 8	2 x 8	2 x 8	2 x 6

1 Use No. 2 or higher grade Southern Pine for footing plate. Alternatively, foundation wall footing plates may be made from two laminations of 23/32-inch APA-RATED SHEATHING 48/24 plywood marked PS1, PS2 or APA Standard PRP-108 and APA Series V-600 for Exposure 1 or APA Series V-611 for Exterior plywood. Fasten plywood laminations together with 16 gauge x 1-1/2-inch stainless steel staples spaced 12 inches o.c. (two rows). Limit width of laminated plywood footing plate to 4 inches wider than bottom plate of foundation wall.

2 Where width of footing plate is 4 inches (nominal) or more wider than that of stud and bottom plate, use continuous 23/32-inch thick treated plywood strips with face grain perpendicular to footing; recommended grade APA-RATED SHEATHING 48/24 plywood marked PS1, PS2 or APA Standard PRP-108 and APA Series V-600 for Exposure 1 or APA Series V-611 for Exterior plywood. Use plywood of same width as footing and fasten to footing with 6d galvanized nails spaced 16 inches (two rows).

3 Table 3 applies for joisted floors (center bearing under first or first and second floors).

NOTE: Use of plywood marked PS2 or PRP-108 should be confirmed per local code requirements.

MINIMUM STRUCTURAL REQUIREMENTS³

TABLE 4 – CRAWL SPACE FOUNDATIONS, ONE-STORY CONSTRUCTION

Stud and plate size (nominal in.)	Stud Spacing (inches o.c.)	No. 1 Southern Pine		No. 2 or higher grade Southern Pine	
		Maximum Building Width (ft.)	Maximum Roof Live Load-Snow (psf)	Maximum Building Width (ft.)	Maximum Roof Live Load-Snow (psf)
2 x 4	24	28	40	28	40
		32	30	32	30
		36	20	36	20
2 x 4	16	36	40	36	40
2 x 6	24	36	40	36	40

TABLE 5 – CRAWL SPACE FOUNDATIONS, TWO-STORY CONSTRUCTION

Stud and plate size (nominal in.)	Stud Spacing (inches o.c.)	No. 1 Southern Pine		No. 2 or higher grade Southern Pine	
		Maximum Building Width (ft.)	Maximum Roof Live Load-Snow (psf)	Maximum Building Width (ft.)	Maximum Roof Live Load-Snow (psf)
2 x 4	24	24	30	24	30
2 x 4	16	32	40	32	40
2 x 4	16	36	30	36	30
2 x 4	12	36	40	36	40
2 x 6	24	36	40	36	40

3 Southern Pine grade combinations apply to 36-foot maximum building width and following uniform load combinations, except as noted in Tables 4 and 5.

CONSTRUCTION PARAMETERS:

- Foundation height: 4 ft. maximum
- Roof supported on exterior bearing walls
- Floor supported on exterior and center interior bearing walls or girder beams
- Equivalent soil fluid density pressure: 30 lbs. per cu. ft.

LOADING CONDITIONS:

- Roof: 40 psf live (snow); 10 psf dead
- Ceiling: 10 psf dead
- First Floor: 40 psf live; 10 psf dead
- Exterior Walls: 8.1 psf dead (65 plf for 8-ft. wall)
- Foundation Walls (including wood footing plate): 7.5 psf (30 plf for 4-ft. wall)

CONSTRUCTION PARAMETERS:

- Foundation height: 4 ft. maximum
- Roof supported on exterior bearing walls
- Floor supported on exterior and center interior bearing walls or girder beams
- Equivalent soil fluid density pressure: 30 lbs. per cu. ft.

LOADING CONDITIONS:

- Roof: 40 psf live (snow); 10 psf dead
- Ceiling: 10 psf dead
- First Floor: 40 psf live; 10 psf dead
- Second Floor: 40 psf live; 10 psf dead
- Exterior Walls: 8.1 psf dead (65 plf for 8-ft. wall)
- Foundation Walls (including wood footing plate): 7.5 psf (30 plf for 4-ft. wall)

FIGURE 11

Low-Profile Crawl Space Foundation

■ **PRESSURE-TREATED SOUTHERN PINE**

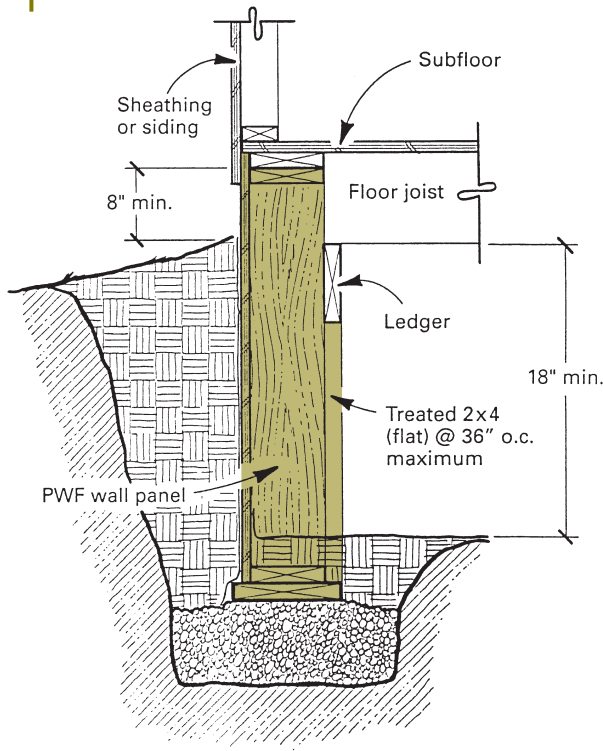


FIGURE 12

Crawl Space with Center Posts

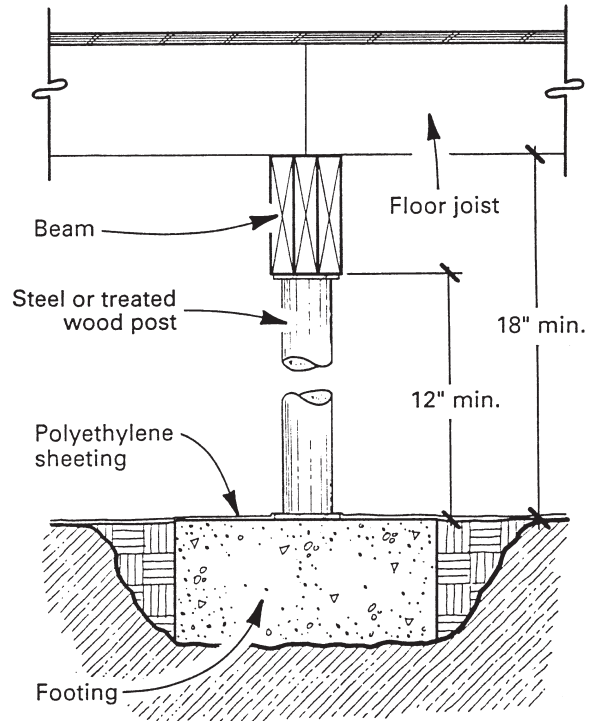


TABLE 6 – PLYWOOD GRADE AND THICKNESS FOR CRAWL SPACE FOUNDATIONS

EQUIVALENT SOIL FLUID DENSITY PRESSURE – 30 LBS. PER CU. FT.

Maximum Differential Backfill (in.)	Stud Spacing (inches)	Face Grain Across Studs			Face Grain Parallel to Studs		
		Grade ¹	Minimum Thickness	Span Rating	Grade ¹	Minimum Thickness ²	Span Rating
32-1/2	12	B	3/8	24/0	A B B	15/32 19/32 (5-ply) 23/32	32/16 40/20 48/24
	16	B	15/32	32/16	A B	19/32 23/32	40/20 48/24
	24	B	23/32	48/24	–	–	–
8-1/2	12	B	3/8	24/0	B	3/8	24/0
	16	B	3/8	24/0	B	15/32	32/16
	24	B	3/8	24/0	A B B	19/32 19/32 (5-ply) 23/32	40/20 40/20 48/24

¹ Recommended all-veneer plywood grades marked PS1, PS2 or APA Standard PRP-108, and APA Series V-600 for Exposure 1 or APA Series V-611 for Exterior panels:

- A. APA STRUCTURAL I RATED SHEATHING
- B. APA RATED SHEATHING

If a major portion of the wall is exposed above ground, a better appearance may be desired. The following Exterior grades marked PS1, PS2 or APA Standard PRP-108, and APA Series V-611 would be suitable.

- A. APA STRUCTURAL I A-C, APA STRUCTURAL I B-C or APA STRUCTURAL I C-C (Plugged).
- B. APA A-C EXTERIOR Group I, APA B-C EXTERIOR Group I, APA C-C (Plugged) EXTERIOR Group I, APA MDO EXTERIOR Group I, or ungrooved APA RATED SIDING 303 Group I.

Use of plywood marked PS2 or PRP-108 should be confirmed per local code requirements.

² When face grain is parallel to studs, all-veneer plywood panels of the required thickness, grade and Span Rating may be of any construction permitted, except as noted in the table for minimum number of plies required.

FIGURE 13

■ PRESSURE-TREATED SOUTHERN PINE

Treated Wood Bearing Wall

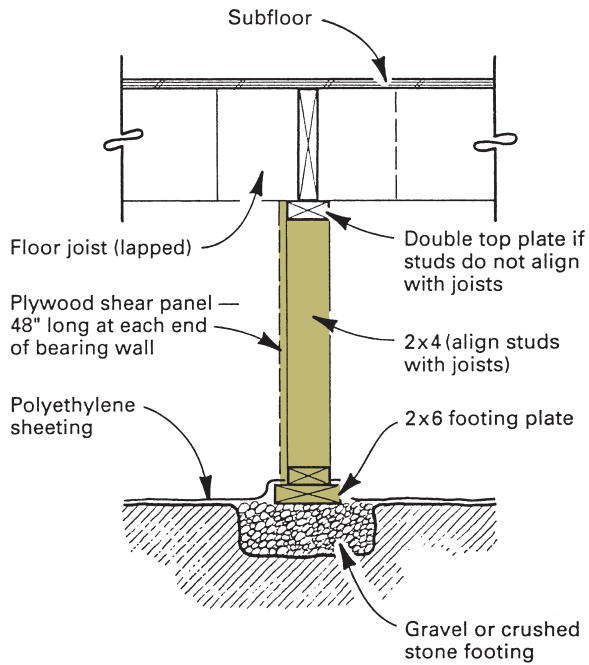


FIGURE 14

Beam Pockets in Basement or Crawl Space Foundation Wall

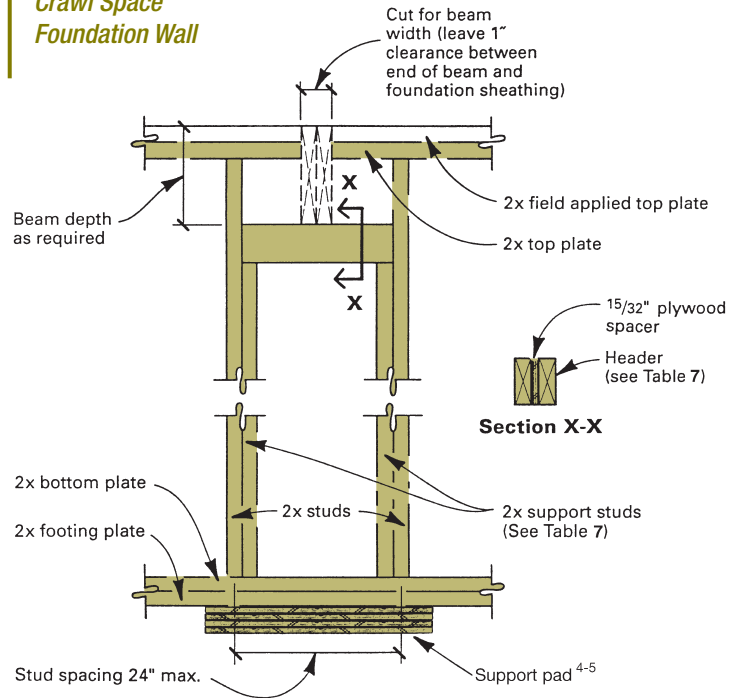


TABLE 7 – BEAM POCKETS IN BASEMENT OR CRAWL SPACE WALLS

MINIMUM SOIL BEARING PRESSURE – 2000 LBS/SQ. FT. STUD SPACING 12 TO 24 INCHES O.C.
HEADER AND STUD SIZES SHOWN ARE FOR NO. 2 GRADE SOUTHERN PINE

Beam Pocket Load (pounds)	Nominal Size & Number of Header Laminations ²	Nominal Size & Number of Support Studs	Minimum Width of Beam Bearing (inches)
2500	2-2x6	1-2x4	1.47
3000	3-2x6	1-2x6	1.18
3000	2-2x8	2-2x4	1.77
3500	2-2x8	2-2x4	2.06
4000	3-2x8	1-2x6	1.57
4000	2-2x10	2-2x4	2.36
4500	3-2x8	1-2x6	1.77
5000	2-2x10	2-2x4	2.95
5000	3-2x8	2-2x6	1.97
5500	2-2x12	2-2x4	3.24
5500	3-2x8	2-2x6	2.16
6000	3-2x10	2-2x6	2.36
6000	2-2x12	3-2x4	3.54
6500	3-2x10	2-2x6	2.56
6500	2-2x12	3-2x4	3.83
7000	3-2x10	2-2x6	2.75
7000	2-2x12	3-2x4	4.13
7500	3-2x10	2-2x6	2.95
7500	2-2x12	3-2x4	4.42
8000	3-2x10	2-2x6	3.15
8000	3-2x12	2-2x6	3.15

- 1 Headers having two laminations of 2-inch (nominal) thickness lumber shall have a 15/32-inch plywood spacer with grain parallel to lumber grain. Headers having three lumber laminations shall have 15/32-inch plywood spacers. Lumber and spacers shall be well spiked together.
- 2 Headers shall not have any splits, checks, or shakes.
- 3 Each ply of support studs shall be nailed to plywood panels with a minimum of 8d common nails at 12" o.c.
- 4 Support pads may be required under beam pockets and at heavy concentrated point loads. Multi-layered treated plywood, lumber or concrete pads per design specification.
- 5 Support pads required when point load exceeds footer plate carrying capacity.

Maximum footer plate carrying capacity (Southern Pine):

2x4875 lb.
2x61375 lb.
2x81812 lb.
2x102312 lb.
2x122812 lb.

BASEMENT FOUNDATIONS

The engineered strength of wood foundation walls, coupled with its ease of installation and insulation, make PWFs ideal for split-entry, “walk-out” to daylight or full-basement designs with below-grade living spaces. It creates basement walls which can be finished without furring to give dryness, warmth and comfort for a truly livable space. Problems with damp, cold basements are solved forever with Permanent Wood Foundations.

DRAINAGE PROVISIONS

The type of basement drainage system to be selected depends on soil conditions. Two types of sumps are recommended for use with basement-type foundations — one for medium to well-drained soils (see Figure 15) and the other for poorly drained soils (see Figure 16). The sump excavation should allow for the gravel bed under and around the sump, and the fill under the basement floor and drainage trenches from the foundation footings should be sloped to drain into the sump, as shown in Figures 1 and 4. An automatic electric sump pump will be needed if the sump cannot be drained by gravity to daylight or to a storm sewer system.

Use of gravel backfill outside foundation wall perimeters should always be utilized in basement constructions to accommodate perimeter drainage, as shown in Figure 17.

FOOTINGS, FRAMING AND SHEATHING

Size of footing plates, framing members and thickness of the sheathing for foundation walls are determined in the same manner as for crawl space foundation walls. Select the footing plate size from Table 3. As an alternate, the PWF may be placed on continuous poured concrete footings, as shown in Figure 19.

Figure 18 illustrates construction details for basement foundations in conventional construction. Tables 8 through 10 list the minimum structural requirements for PWF stud wall framing members for buildings up to 36' wide, with one or two stories above the foundation. For certain stud sizes and

grades, the length of end splits or checks at the lower end of studs must not exceed the width of the stud, when backfill heights for basement foundations exceed 72". Minimum plywood thicknesses are shown in Table 11 for backfill heights up to 86".

To resist lateral loads from earth backfill, coupled with vertical loads on the foundation wall from the structure, the following guidelines should be considered when determining basement foundation construction details:

(a) For split-entry and basement PWFs, 2x6 studs spaced 16" o.c. are generally necessary for backfill heights up to 60", or 12" o.c. for backfill heights to 72". For backfill heights over 72" (up to 86"), 2x8 studs spaced 12" or 16" o.c. are usually required. For some applications, the next smaller stud size or greater stud spacing may be permitted when No. 1 grade lumber is used (see Tables 8 through 10), but material availability and costs should be considered first.

(b) When backfill height is 72" or greater, each PWF stud and floor framing should be connected to the top plate with framing anchors. See Figures 20 and 21 for construction details, and Tables A3 and A4 in Appendix III (page 48) for recommended fastener schedules and framing anchor options.

(c) When floor joists are oriented parallel to the foundation wall, full-depth blocking is required in the outer joist space along the foundation wall, for backfill heights over 48". See Figure 21 for construction details, and Tables A4 and A5 in Appendix III (pages 48 - 49) for nailing schedules and framing anchor options.

(d) For backfill heights up to 86", the bottom edge of the foundation studs should bear against at least 2" of the perimeter screed board or concrete slab basement floor at the base of the foundation wall (see Figures 18 and 19), or against the perimeter band joist framing of the treated wood basement floor.

The PWF adapts easily to “walk-out” daylight basement configurations on sloping sites. In daylight basements, the concrete slab basement floor should be poured to “key” between the studs of the foundation side and end walls, as shown in Figure 23.

Where there is more than a 48" difference in height of backfill on opposite sides of the house, fastening of plywood sheathing on foundation end walls may have to be increased so that the walls act as shear walls to resist unbalanced lateral forces from the differing backfill heights on opposing foundation walls.

Table A1 in Appendix III gives required fastening for plywood foundation wall sheathing for foundation walls which act as shear walls, for 72" maximum differential in backfill height.

One or two interior shear walls located in the basement near the mid-length of the house may also be necessary to reduce shear forces on end walls. Figure 40 provides guidance for determining when such walls are needed. Figure 41 shows suggested construction details for a room partition wall that can serve as an interior shear wall, including special details for connecting the wall to the "uphill" foundation wall, the upper main level floor framing system, and the concrete slab basement floor.

If there is low backfill, a PWF stub wall can be used in the lower part of the daylight foundation wall, with untreated material in the upper part. Figures 25 and 26 show ways of reducing costs by using treated material only where necessary. Figure 24 shows details for an insulated stem wall PWF for "frost wall" foundations that can be used with on-grade or daylight basement concrete slab floors in moderate or cold climates.

For sloping sites, and for tri-level house designs which have adjoining basement and crawl space foundations, stepped foundation footings are often required. Construction details are illustrated in Figure 27.

Brick veneer exterior finish may be supported on a treated wood knee-wall installed outside the foundation, or directly on the foundation wall when 2x8 framing is used for PWF walls (see Figures 28 and 29).

An unsheathed treated wood knee-wall (see Figure 28) can be used to support brick veneer exterior finish up to 18' high, using knee-wall framing of at least 2x4 studs spaced 16" o.c., with a 1x4 bottom plate and a 2x6 top plate. Provide double studs under all butt joints in the top plate.

The footing plates for knee-walls must be 2x10 where 2x4 foundation studs are required, per Tables 5 or 6, or 2x12 where 2x6 foundation studs are required. Alternatively, the footing plate may be fabricated from two laminations of 23/32" thick plywood, or from two widths of lumber, with the edge joints offset from PWF and knee-wall bottom plates. Fasten treated plywood to the bottom of two-piece lumber footing plates (see Footnote 2, Table 3 for details). For basement foundations, polyethylene sheathing should be placed between the foundation wall sheathing and knee-wall framing, before the knee-wall is attached to the foundation.

Window and sliding door openings in foundation walls for split-entry or raised ranch houses, as well as full and daylight basement houses, are shown in Figures 30 and 31. Fireplace details are shown in Figure 33. Foundation details for garage walls are shown in Figure 34.

FLOOR CONSTRUCTION

The floor may be framed conventionally with lumber joists set on the sill plate, or with floor trusses or structural I-joists. Interior supports for floor framing may be posts and girder beams shown in Figure 34, or a load-bearing partition wall in the basement, as shown in Figure 35. Beam pockets for floor support girders are shown in Figure 14 and Table 7.

Figures 37 and 38 show how clear-span trusses can be used with the PWF. Since Tables 8 and 9 assume a load-bearing wall in the center of the house, they are not directly applicable when clear-span trusses or I-joists are used. Table 1 can be used to select the framing for non-load-bearing walls, but tables in the DFI Manual must be used to determine framing requirements for foundation walls when clear-span floor trusses or I-joists are used.

When stairwell openings are adjacent to foundation walls, a multiple-layer top plate must be used at the top of PWF walls to act as a horizontal beam spanning between the stairwell headers. Recommended stairwell framing details are shown in Figure 39 and Table 12.

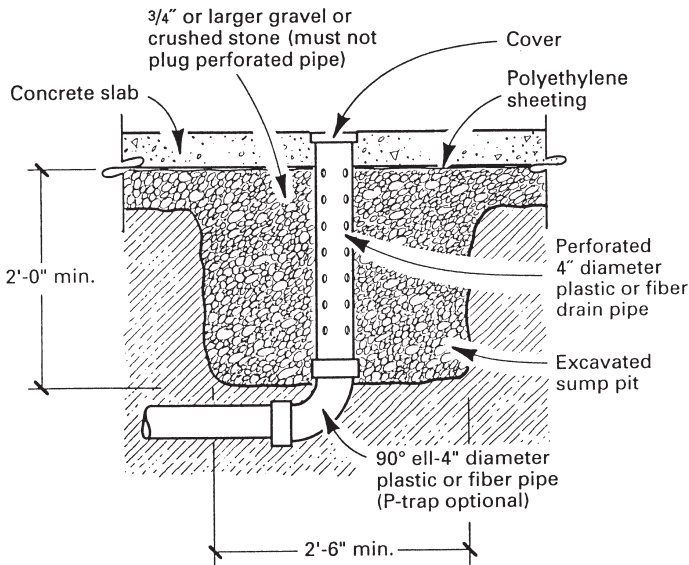
FIGURE 15

Sump for Medium to Well-Drained Soils
Groups I and II

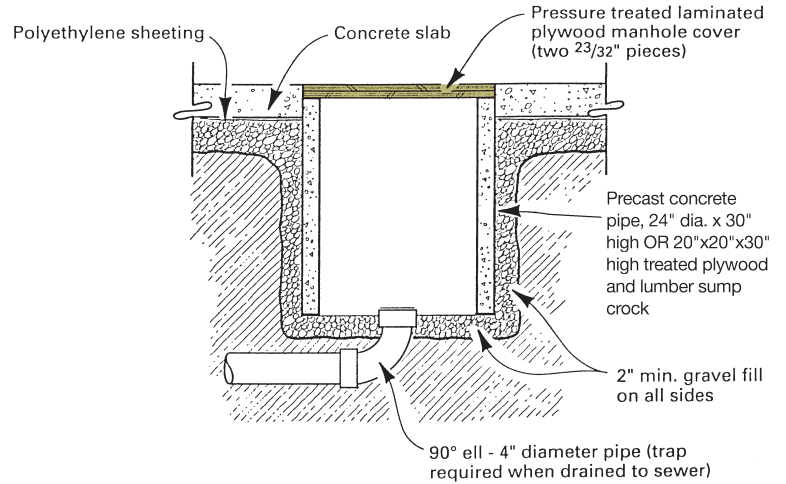
■ **PRESSURE-TREATED SOUTHERN PINE**

FIGURE 16

Sump for Poorly Drained Soils
Group III



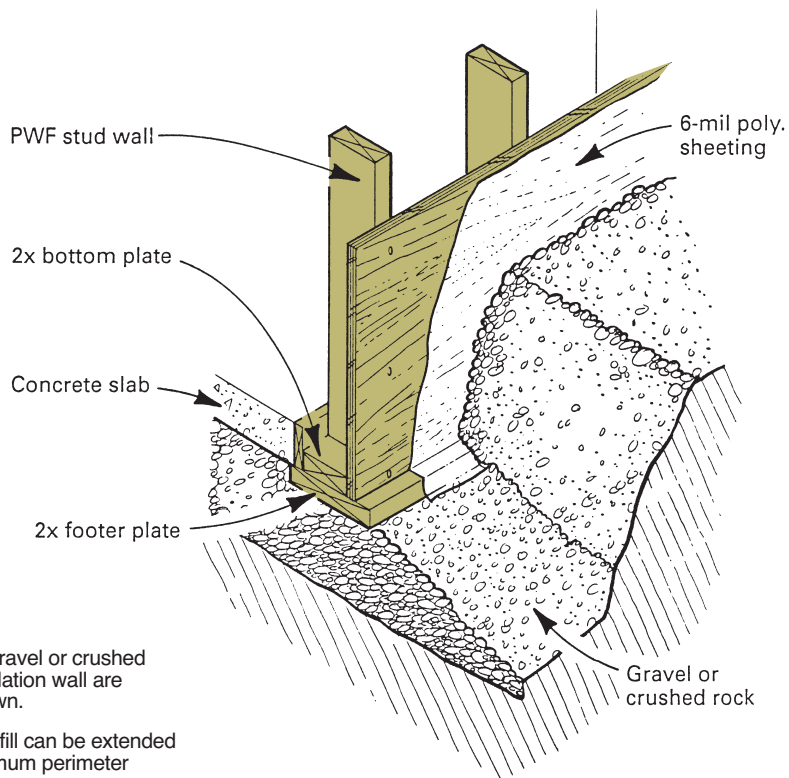
NOTE: Vertical pipe may be extended through slab with a clean-out plug in floor.



NOTE: Use of sump pump is required when sump cannot be drained by gravity to daylight or sewer.

FIGURE 17

Basement PWF with Perimeter Gravel Drainage
in conjunction with Sump System



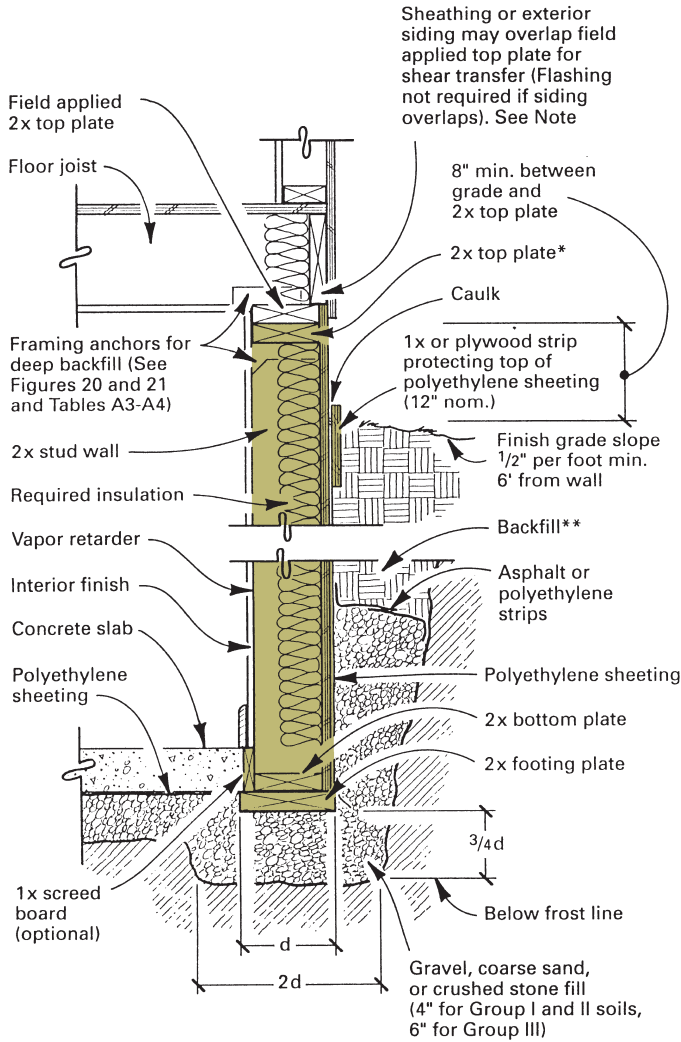
NOTES:

- (1) In basement PWF constructions, gravel or crushed rock backfills half way up the foundation wall are recommended and typical, as shown.
- (2) In poorly drained soils, gravel backfill can be extended up to just below grade line for optimum perimeter drainage.

FIGURE 18

Basement Foundation

■ PRESSURE-TREATED SOUTHERN PINE



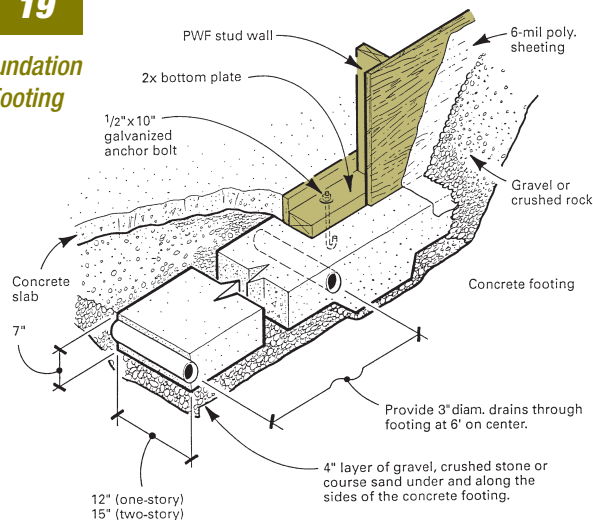
* Not required to be treated if backfill is more than 8' below bottom of plate. Typical for all details

** Backfill with crushed stone or gravel 12" for Group I soils, and half the backfill height for Groups II and III soils.

NOTE: For daylight basement foundations, use double header joists (stagger end joints) or splice header joist for continuity on uphill and daylight sides of building.

FIGURE 19

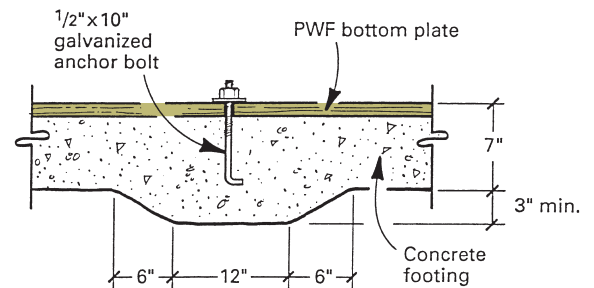
Basement Foundation on Concrete Footing



NOTES:

- (1) Provide drains through footing at 6' on center.
- (2) 4" layer of gravel, crushed stone or coarse sand under and along the sides of the concrete footing.

Concrete Footing Detail at Foundation Anchor Bolts



MINIMUM STRUCTURAL REQUIREMENTS

TABLE 8 – BASEMENT FOUNDATIONS, ONE-STORY CONSTRUCTION

Maximum Backfill Height (in.)	Stud and Plate Size (nominal in.)	Stud Spacing (inches o.c.)	No. 1 Southern Pine		No. 2 or higher grade Southern Pine ²	
			Maximum Building Width (ft.)	Maximum Roof Live Load-Snow (psf)	Maximum Building Width (ft.)	Maximum Roof Live Load-Snow (psf)
86	2 x 6	12	36	40	36 (No.1)	40
	2 x 8	16	36	40	36	40
72	2 x 6	16	36	40	36 (No.1)	40
60	2 x 6	16	36	40	36	40
48 or less ¹	2 x 6	16	36	40	36	40

¹ For backfill heights of 48 inches or less, 2x4 studs on 12 or 16 inch o.c. may be used for PWF basement walls in one-story construction. See the *DFI Manual for PWF* for complete details, available from AF&PA.

CONSTRUCTION PARAMETERS:

- Foundation height: 8 ft. maximum
- Roof supported on exterior bearing walls
- Floor supported on exterior and center interior bearing walls or girder beams
- Equivalent soil fluid density pressure: 30 lbs. per cu. ft.

LOADING CONDITIONS:

- Roof: 40 psf live (snow); 10 psf dead
- Ceiling: 10 psf dead
- First Floor: 40 psf live; 10 psf dead
- Exterior Walls: 8.1 psf dead (65 plf for 8-ft. wall)
- Foundation Walls (including wood footing plate): 6.9 psf (55 plf for 8-ft. wall)

² Except use No.1 Southern Pine where indicated.

TABLE 9 – BASEMENT FOUNDATIONS, TWO-STORY CONSTRUCTION

Maximum Backfill Height (in.)	Stud and Plate Size (nominal in.)	Stud Spacing (inches o.c.)	No. 1 Southern Pine		No. 2 or higher grade Southern Pine ²	
			Maximum Building Width (ft.)	Maximum Roof Live Load-Snow (psf)	Maximum Building Width (ft.)	Maximum Roof Live Load-Snow (psf)
86	2 x 6	12	36	40	36 (No.1)	40
	2 x 8	16	36	40	36	40
72	2 x 6	16	32	40	32	40
	2 x 6	16	36	40	36 (No.1)	40
	2 x 6	12	36	40	36	40
	2 x 8	16	36	40	36	40
60	2 x 6	16	36	40	36	40
48 or less ¹	2 x 6	16	36	40	36	40

¹ For backfill heights of 48 inches or less, 2x4 studs on 12 or 16 inch o.c. may be used for PWF basement walls in one-story construction. See the *DFI Manual for PWF* for complete details, available from AF&PA.

CONSTRUCTION PARAMETERS:

- Foundation height: 8 ft. maximum
- Roof supported on exterior bearing walls
- Floor supported on exterior and center interior bearing walls or girder beams
- Equivalent soil fluid density pressure: 30 lbs. per cu. ft.

LOADING CONDITIONS:

- Roof: 40 psf live (snow); 10 psf dead
- Ceiling: 10 psf dead
- First Floor: 40 psf live; 10 psf dead
- Second Floor: 40 psf live; 10 psf dead
- Exterior Walls: 8.1 psf dead (65 plf for 8-ft. wall)
- Foundation Walls (including wood footing plate): 6.9 psf (55 plf for 8-ft. wall)

² Except use No.1 Southern Pine where indicated.

TABLE 10 – NON-LOAD BEARING BASEMENT FOUNDATIONS, ONE AND TWO-STORY CONSTRUCTION

Maximum Backfill Height (in.)	Stud and Plate ¹ Size (nominal in.)	Stud Spacing (inches o.c.)	No. 1 Southern Pine		No. 2 Southern Pine	
			Maximum Building Width (ft.)	Maximum Roof Live Load-Snow (psf)	Maximum Building Width (ft.)	Maximum Roof Live Load-Snow (psf)
86	2 x 6	12	**	**	**	**
	2 x 8	16	**	**	**	**
72	2 x 6	16	**	**	**	**
60	2 x 4	12	**	**	**	**
	2 x 6	16	**	**	**	**
48	2 x 4	16	**	**	**	**
36 or less	2 x 4	16	**	**	**	**

** Applies to all building widths and following uniform load conditions for non-load bearing basement foundation walls.

CONSTRUCTION PARAMETERS:

- Foundation height: 8 ft. maximum
- Roof or floors **not** supported on exterior wall (non-bearing except for wall dead loads).
- Equivalent soil fluid density pressure: 30 lbs. per cu. ft.

LOADING CONDITIONS:

- Exterior Walls: 8.1 psf dead (65 plf for 8-ft. wall)
- Foundation Walls (including wood footing plate): 6.9 psf (55 plf for 8-ft. wall)

¹ No. 2 or higher grade Southern Pine

NOTE: The minimum structural requirements specified in Tables 8, 9 and 10 are applicable for **8-foot maximum** basement foundation walls.

FIGURE 20

Fastening Foundation Side Walls to Floor System

■ PRESSURE-TREATED SOUTHERN PINE

FIGURE 21

Fastening Foundation End Walls to Floor System

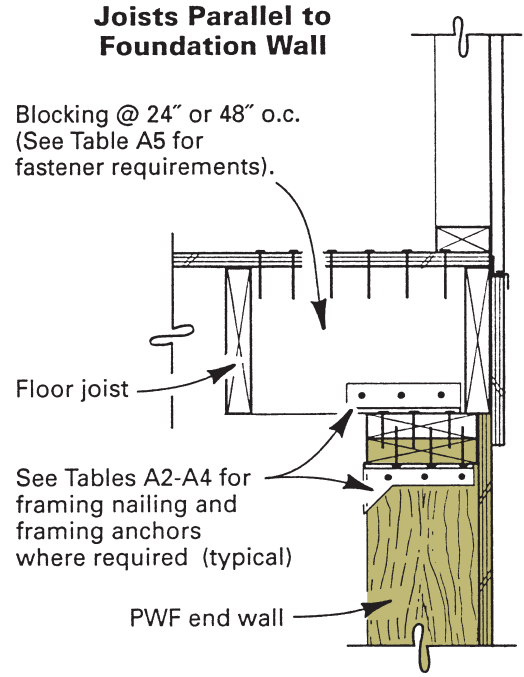
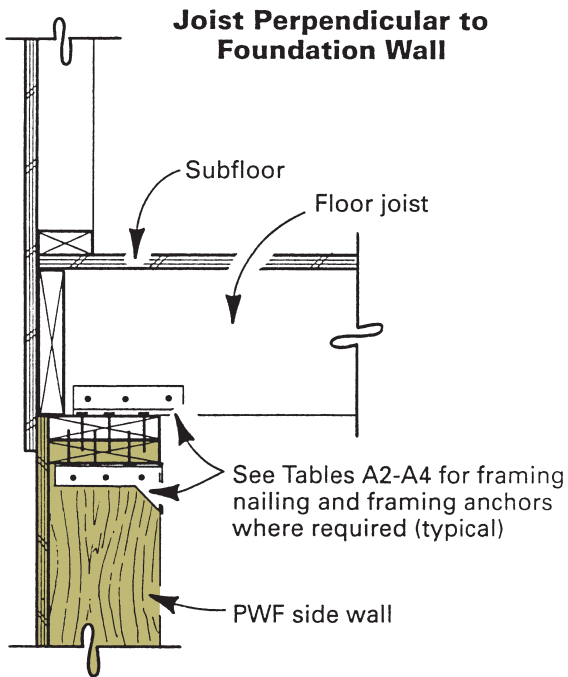
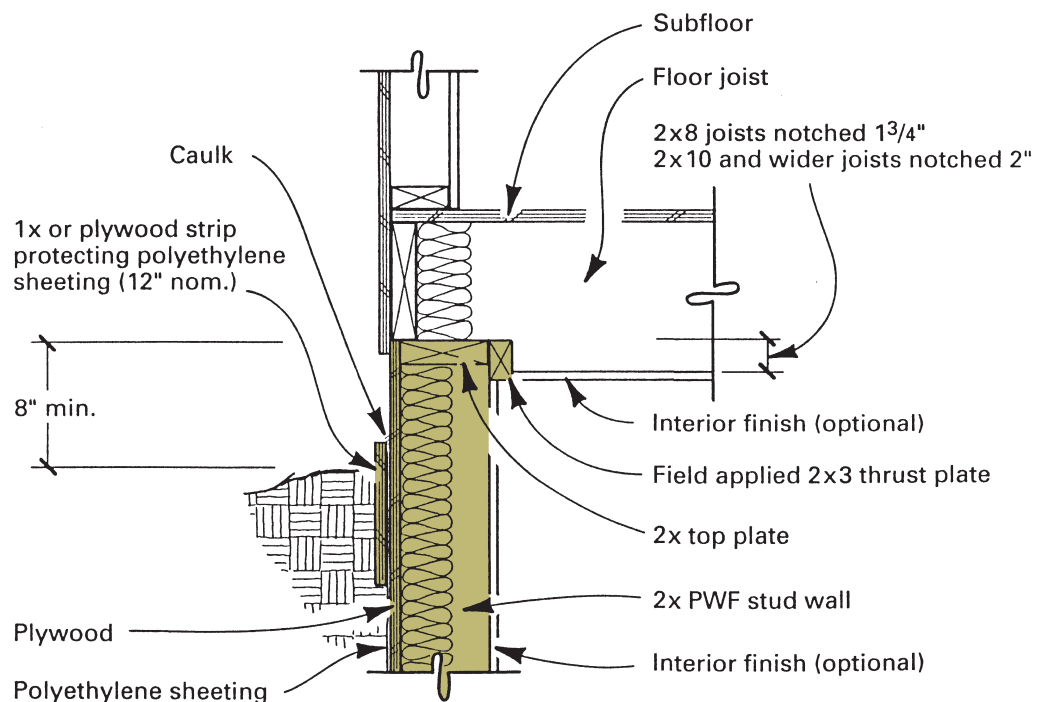


FIGURE 22

*Fastening Foundation Side Walls to Floor System Alternate Method**



NOTE: Nailing to be as normally required for shallow or no fill. Lateral soil forces transferred through 2 x 3 thrust plate.

TABLE 11 – PLYWOOD GRADE & THICKNESS FOR BASEMENT FOUNDATIONS

EQUIVALENT SOIL FLUID DENSITY PRESSURE – 30 LBS. PER CU. FT.

Height of fill (inches)	Stud Spacing (inches)	Face grain across studs ¹			Face grain parallel to studs		
		Grade ²	Minimum Thickness	Span Rating	Grade ²	Minimum Thickness ³	Span Rating
86	12	B	19/32	40/20	A A	19/32 ⁴ 23/32	40/20 48/24
	16	B	23/32 ⁴	48/24	–	–	–
72	12	B	15/32 ⁴	32/16	A B	19/32 23/32 ⁴	40/20 48/24
	16	B	23/32 ⁴	48/24	–	–	–
60	12	B	15/32	32/16	A B A	19/32 19/32 ⁴ (5-ply) 23/32	40/20 40/20 48/24
	16	B	19/32 ⁴	40/20	A	23/32 ⁴	48/24
48	12	B	15/32	32/16	A B	15/32 ⁴ 19/32 ⁴ (4-ply)	32/16 40/20
	16	B	19/32	40/20	A B	19/32 ⁴ 23/32	40/20 48/24
36	12	B	15/32	32/16	A B A	15/32 15/32 ⁴ (4-ply) 19/32 (4-ply)	32/16 32/16 40/20
	16	B	15/32 ⁴	32/16	A B	19/32 23/32	40/20 48/24
24	12	B	15/32	32/16	A B	15/32 15/32 ⁴	32/16 32/16
	16	B	15/32	32/16	A B	15/32 ⁴ 19/32 ⁴ (4-ply)	32/16 40/20

1 Minimum 2-inch blocking between studs required at all horizontal panel joints more than 4 feet below adjacent ground level (also where noted in construction details).

2 Recommended all-veneer plywood grades marked PS1, PS2 or APA Standard PRP-108, and APA Series V-600 for Exposure 1 or APA Series V-611 for Exterior panels:

A. APA STRUCTURAL I RATED SHEATHING

B. APA-RATED SHEATHING

If a major portion of the wall is exposed above ground, a better appearance may be desired.

The following Exterior grades marked PS1, PS2 or APA Standard PRP-108, and APA Series V-611 would be suitable:

A. APA STRUCTURAL I A-C, APA STRUCTURAL I B-C or APA STRUCTURAL I C-C (Plugged).

B. APA A-C EXTERIOR Group 1, APA B-C EXTERIOR Group 1, APA C-C (Plugged) EXTERIOR Group 1,

APA MDO EXTERIOR Group 1, or ungrooved APA-RATED SIDING 303 Group 1.

Use of plywood marked PS2 or PRP-108 should be confirmed per local code requirements.

3 When face grain is parallel to studs, all-veneer plywood panels of the required thickness, grade and Span Rating may be of any construction permitted except as noted in the table for minimum number of plies required.

4 For this fill height, thickness and grade combination, panels which are continuous over less than three spans require blocking 16 inches above the bottom plate. Offset adjacent blocks and fasten through studs with two 16d corrosion resistant nails at each end.

FIGURE 23

■ **PRESSURE-TREATED SOUTHERN PINE**

Daylight Basement End Walls

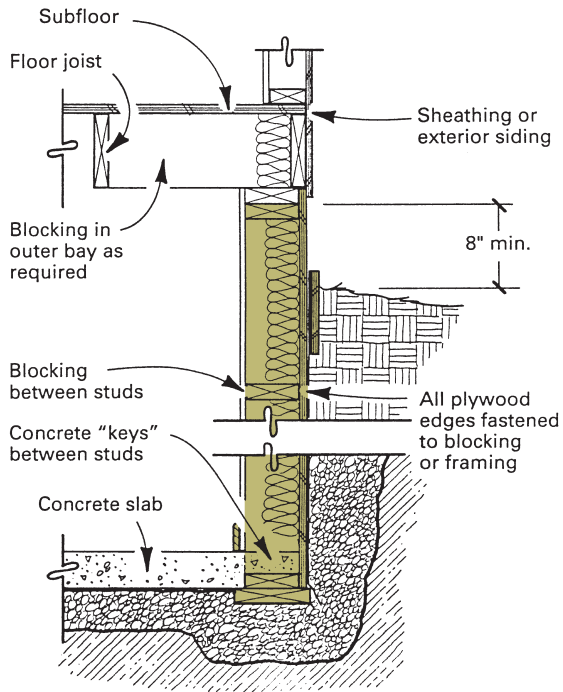


FIGURE 24

**PWF Stem Wall
Concrete Slab on Grade**

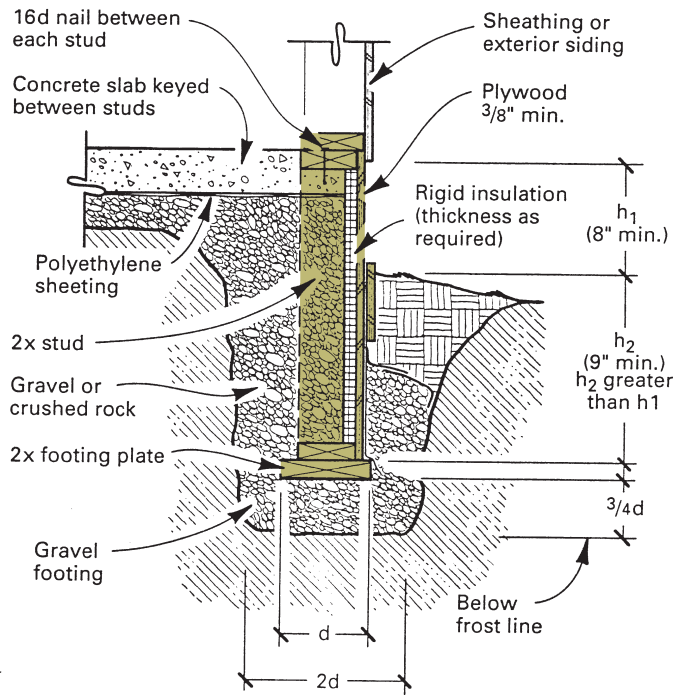


FIGURE 25

**Basement Foundation Stub Wall
Low Backfill**

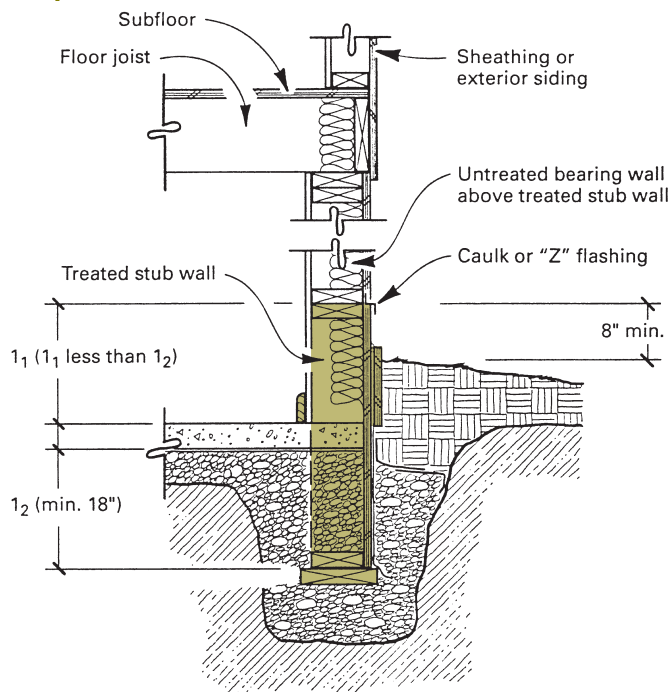


FIGURE 26

**Basement Foundation Wall
Partial Backfill**

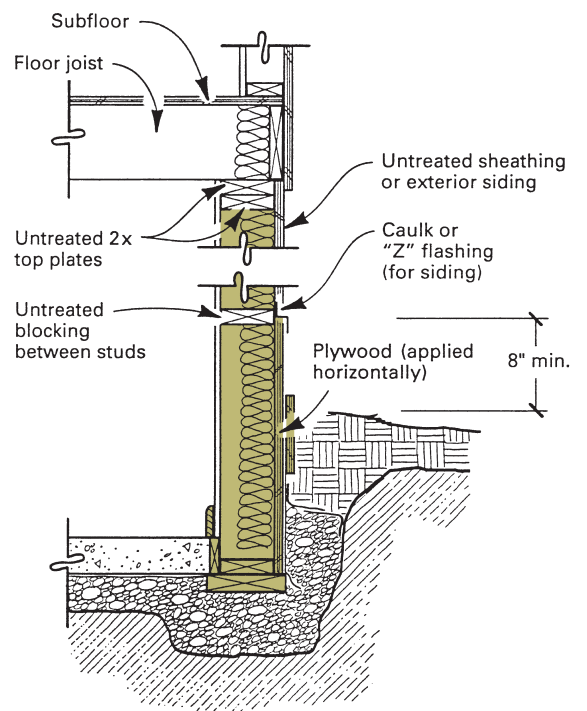
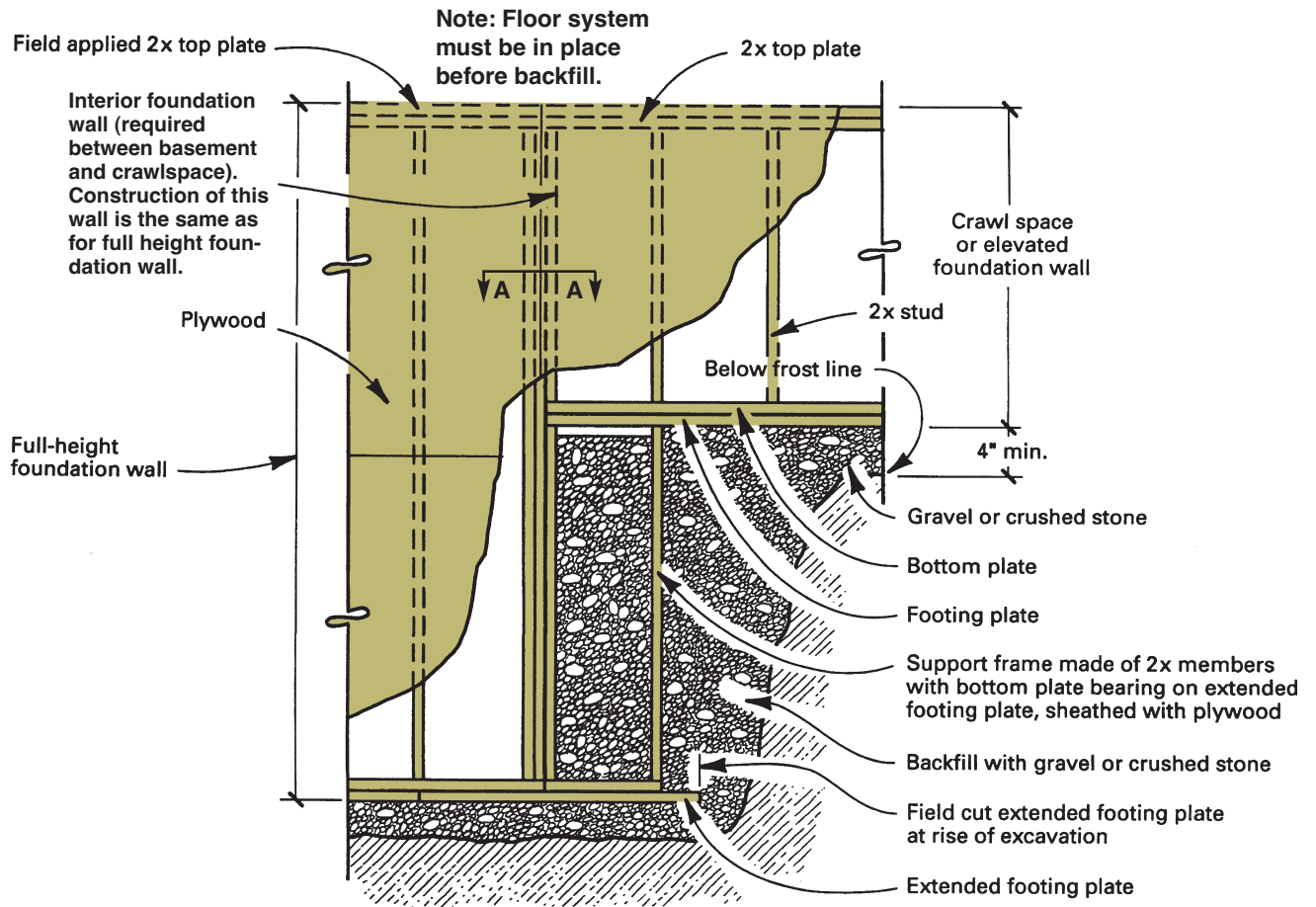


FIGURE 27

■ **PRESSURE-TREATED SOUTHERN PINE**

Stepped Footing

Crawl Space or Basement Foundation



FIELD INSTALLATION SEQUENCE

- (1) Install full-height foundation wall and extended footing plate.
- (2) Install interior foundation wall (required between basement and crawl space areas).
- (3) Install support frame.
- (4) Cover support frame with plywood sheathing.
- (5) Place gravel or crushed stone around support frame.
- (6) Install crawl space wall.

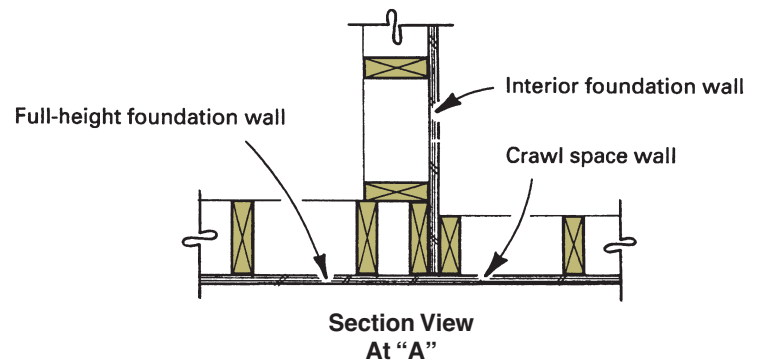


FIGURE 28

Knee Wall with Brick Veneer

■ **PRESSURE-TREATED SOUTHERN PINE**

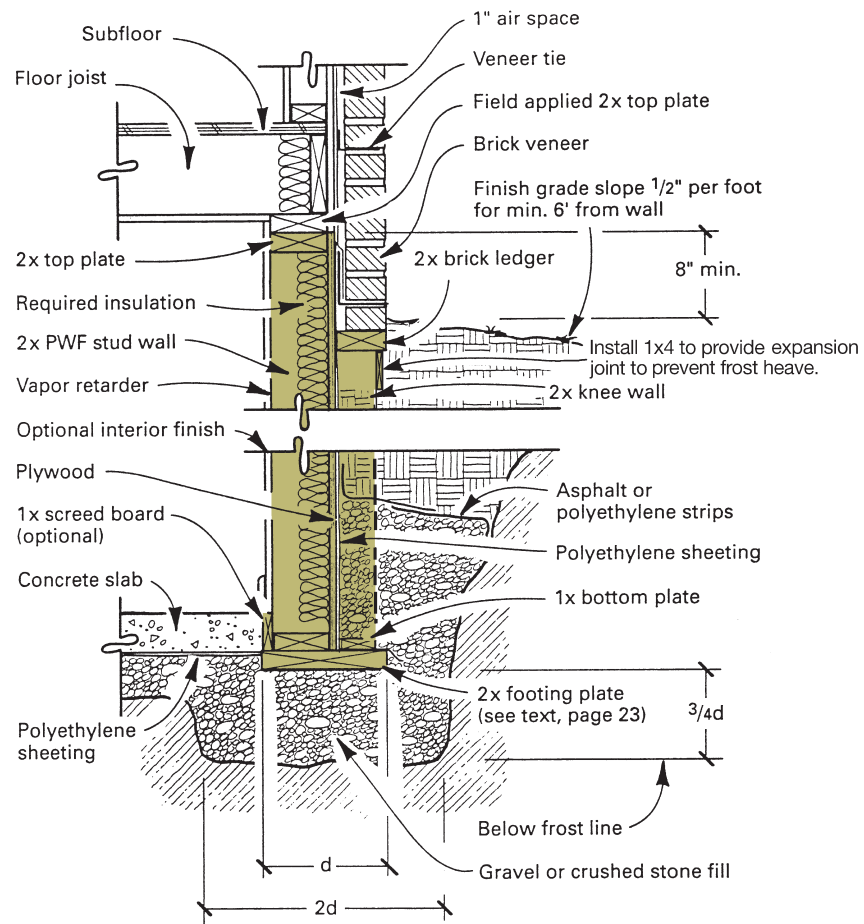


FIGURE 29

*Alternate Brick Veneer Detail
Crawl Space Construction*

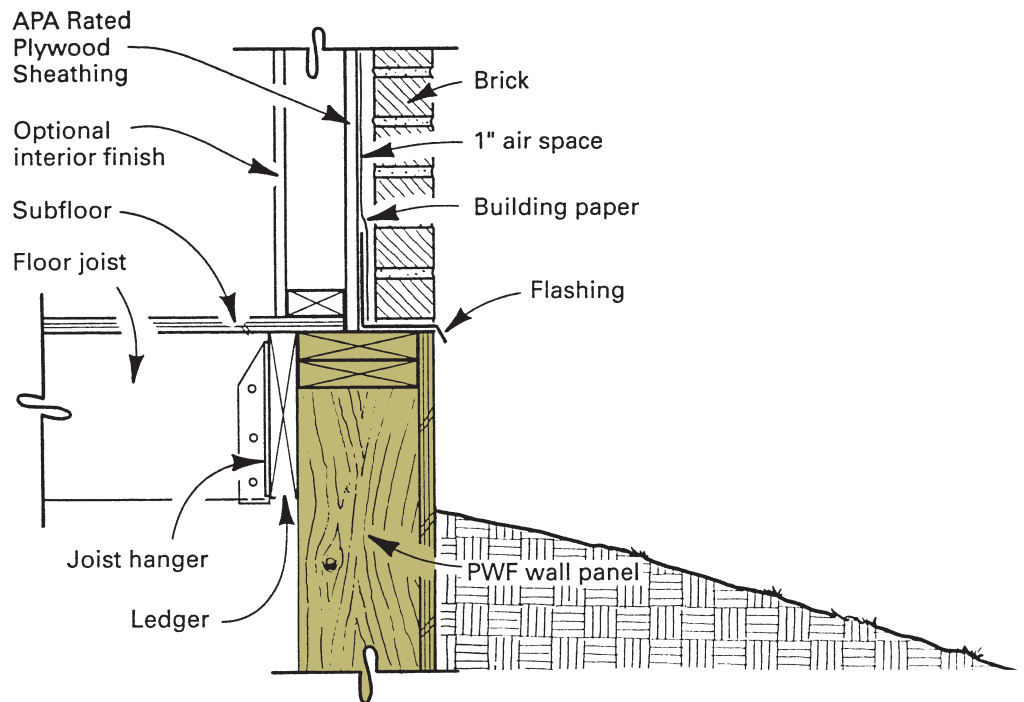
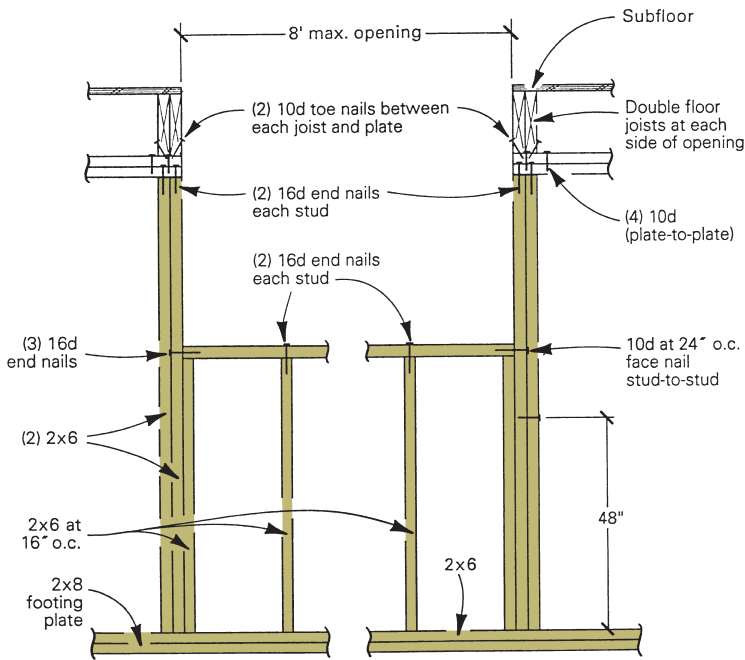


FIGURE 30

■ PRESSURE-TREATED SOUTHERN PINE

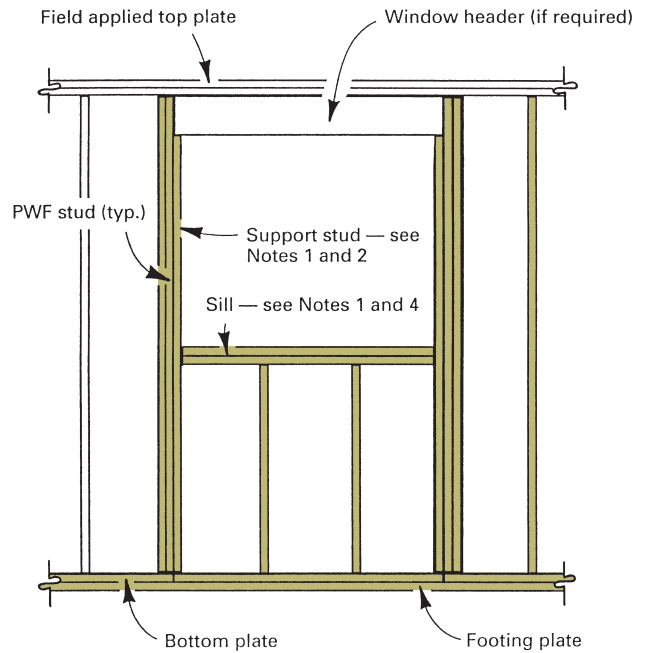
Framing for Split Entry
(maximum backfill: 40")



- NOTES:** (1) Sills and support studs shall be doubled when required by structural design to support lateral loads.
(2) Support studs shall extend in one piece from header to bottom plate.

FIGURE 31

Typical Framing Detail for Window Opening in Foundation Wall



- (3) Fastenings for window framing shall be adequate for loads (see Appendix III, Tables A2 and A3).
(4) Sill may not require treatment if ground clearance is adequate.

FIGURE 32

Typical Framing Detail for Patio Door Opening in Foundation Wall

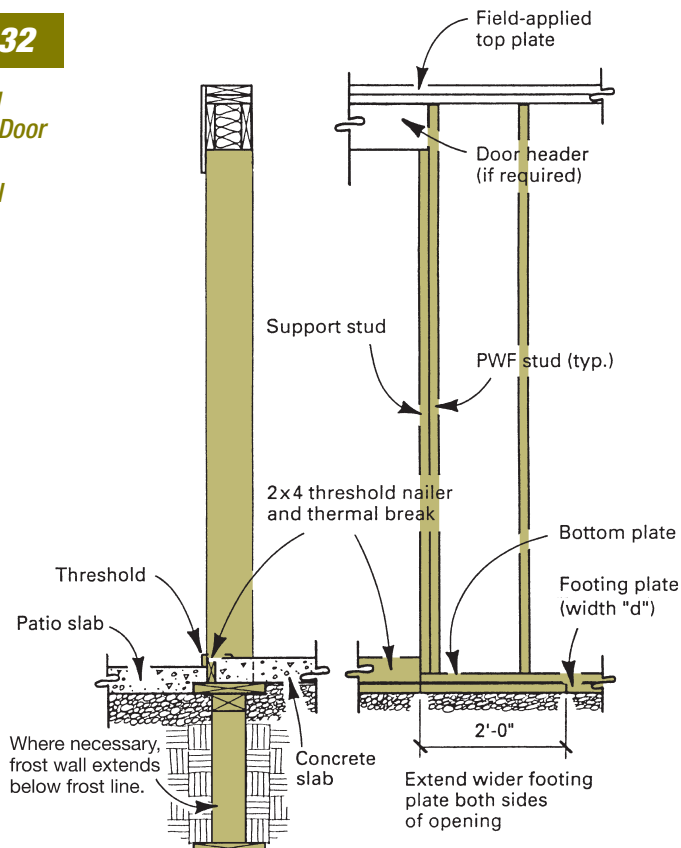
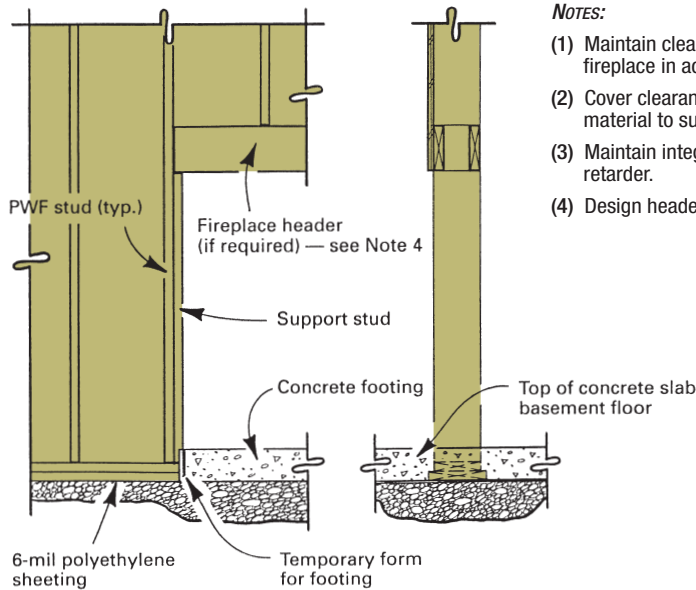


FIGURE 33

Typical Framing Detail for Fireplace Opening in Foundation Wall

■ **PRESSURE-TREATED SOUTHERN PINE**



NOTES:

- (1) Maintain clearances between wall framing and fireplace in accordance with applicable building code.
- (2) Cover clearance space with rigid noncombustible material to support soil loads; caulk joints.
- (3) Maintain integrity of polyethylene sheeting moisture retarder.
- (4) Design header and footing for applicable loads.

FIGURE 34

Attached Garage PWF Details (Basement Construction)

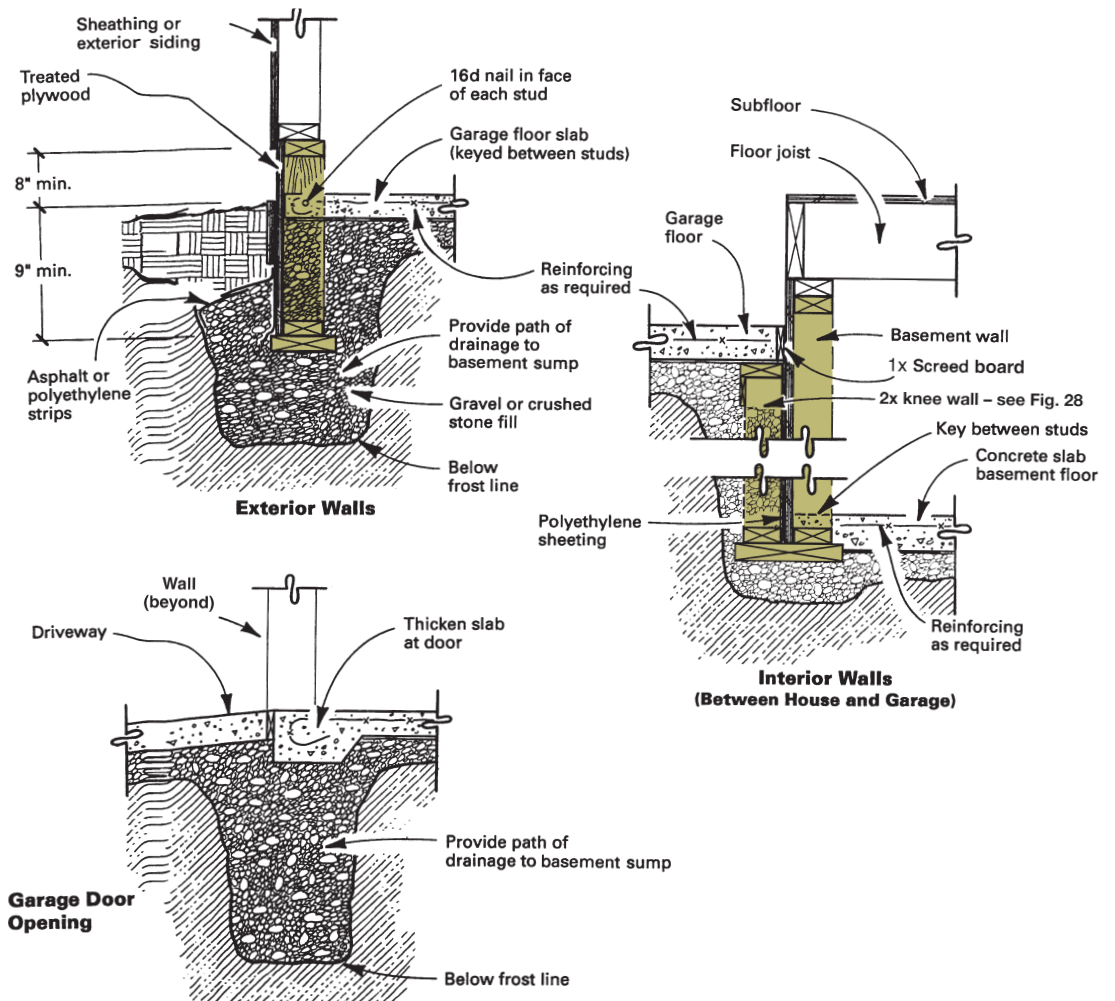


FIGURE 35

Basement Post

■ **PRESSURE-TREATED
SOUTHERN PINE**

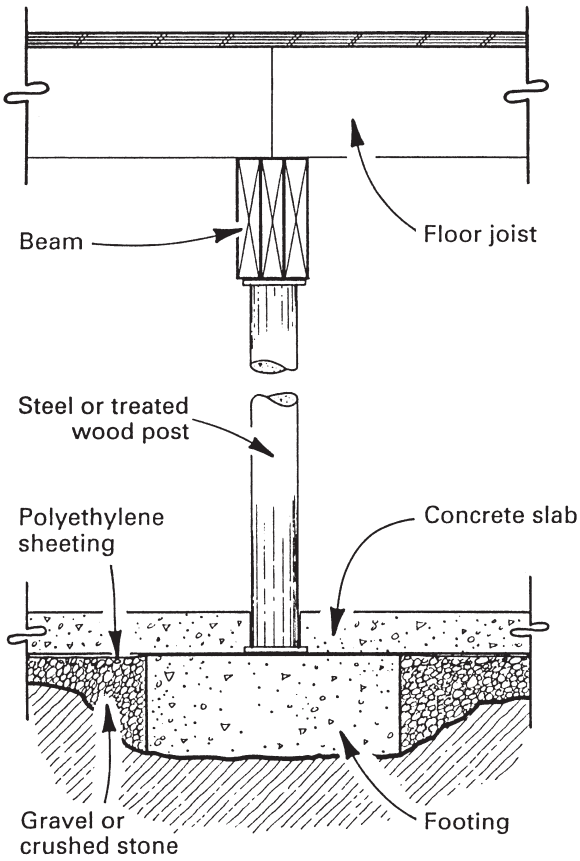


FIGURE 36

Basement Bearing Partition

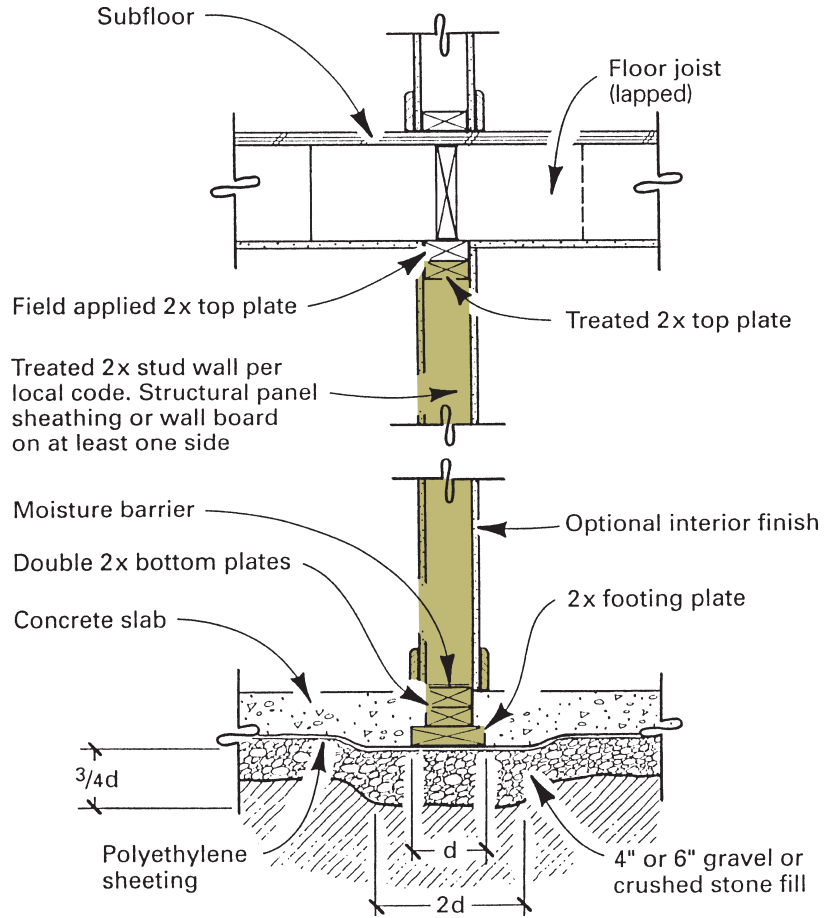
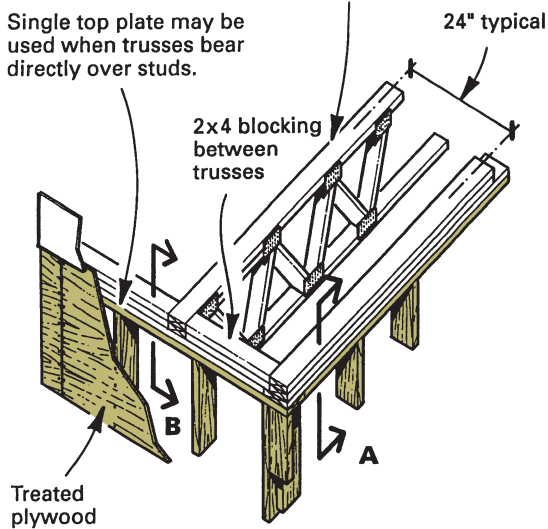


FIGURE 37

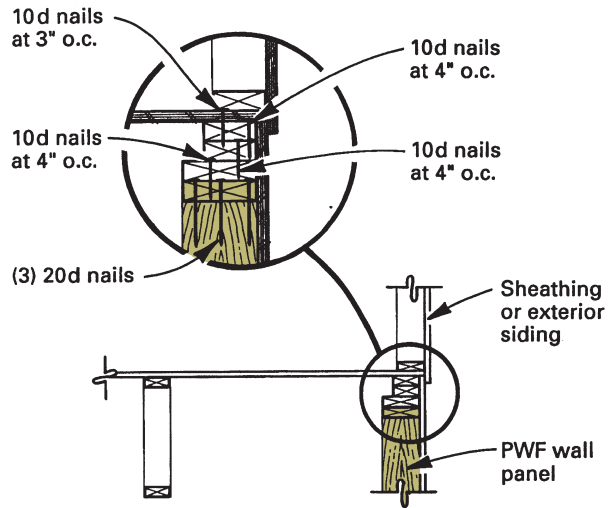
■ PRESSURE-TREATED SOUTHERN PINE

Clear-Span Trusses Top-Chord Support

Floor truss design should account for appropriate lateral loads.

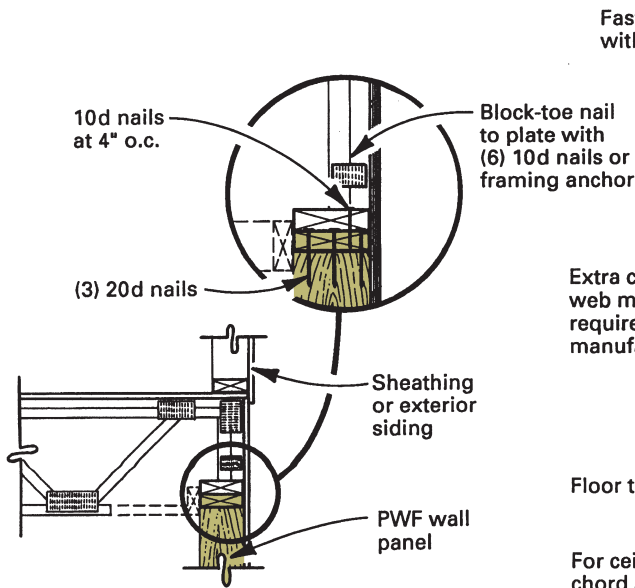


Framing at Corner

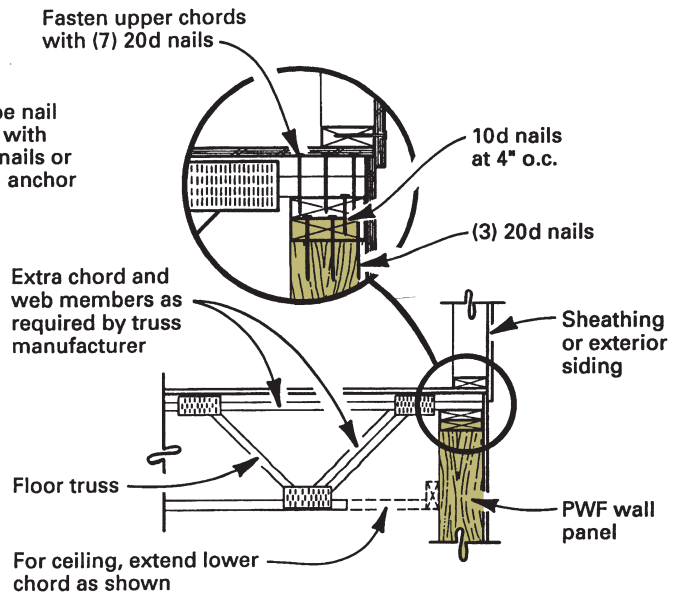


May be simplified when longer studs are used. See "Alternate End Wall" detail Fig. 38.

End Wall Section A



Alternate Side Wall Section B



Side Wall Section B

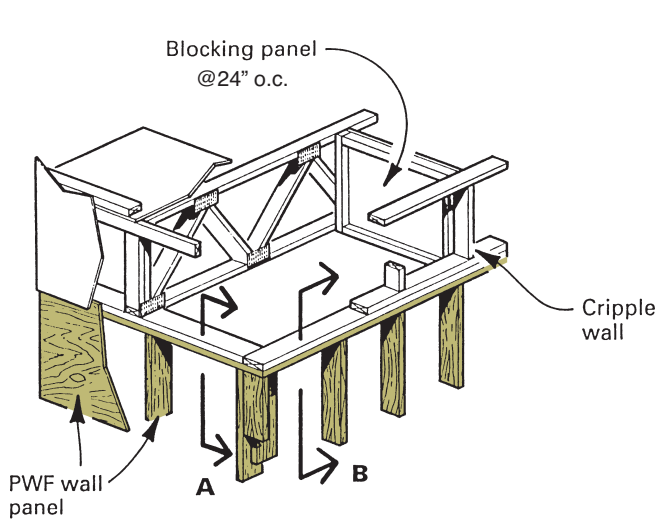
NOTES:

- (1) Fastener schedule shown for 7' fill. Fasteners may be reduced for lesser fill heights. For 4' fill, fasteners may be reduced 50%.
- (2) For design of load-bearing sidewalls, see *DFI Manual*.

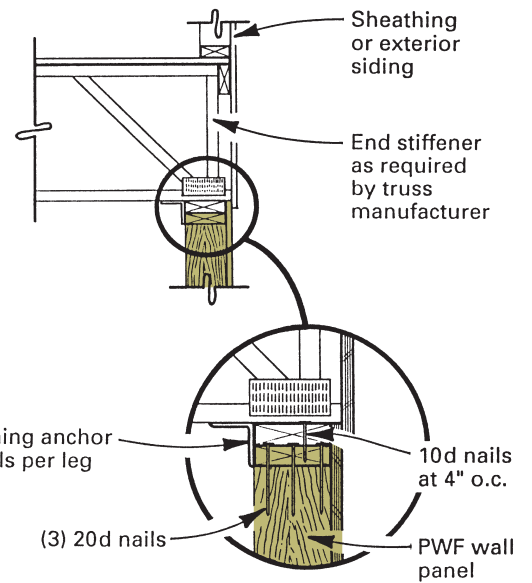
FIGURE 38

■ **PRESSURE-TREATED SOUTHERN PINE**

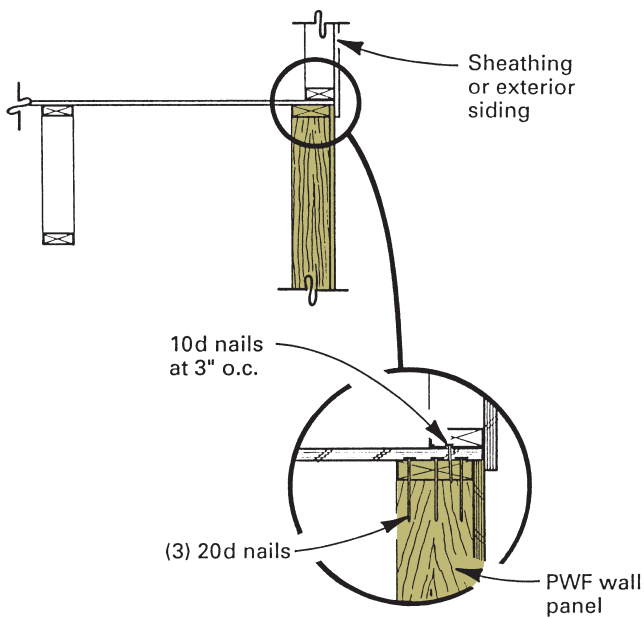
Clear-Span Trusses
Bottom-Chord Support



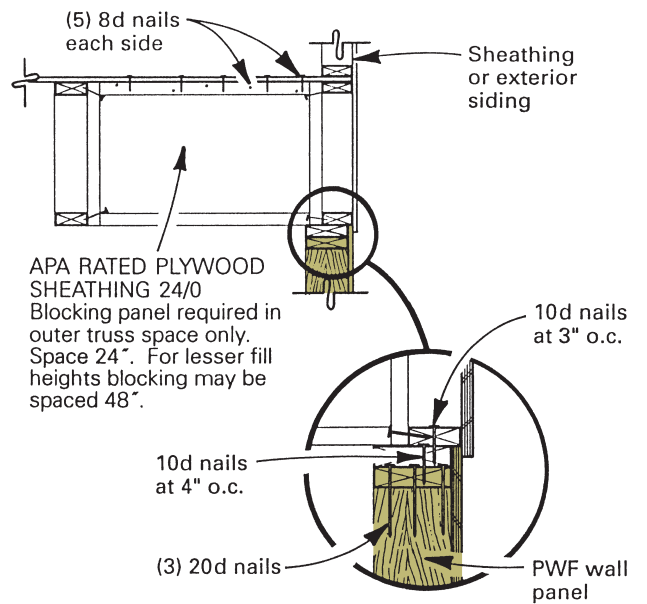
Framing at Corner



Side Wall Section A



Alternate End Wall (with longer studs)



End Wall Section B

NOTES:

Fastener spacing for side and end wall is based on 7' fill. See Note 1, Figure 38, for fasteners for other fill heights.

Taller end-wall may require different design.

FIGURE 39

■ **PRESSURE-TREATED
SOUTHERN PINE**

*Typical Framing
Details for Stairwell
Adjacent to
Foundation Wall*

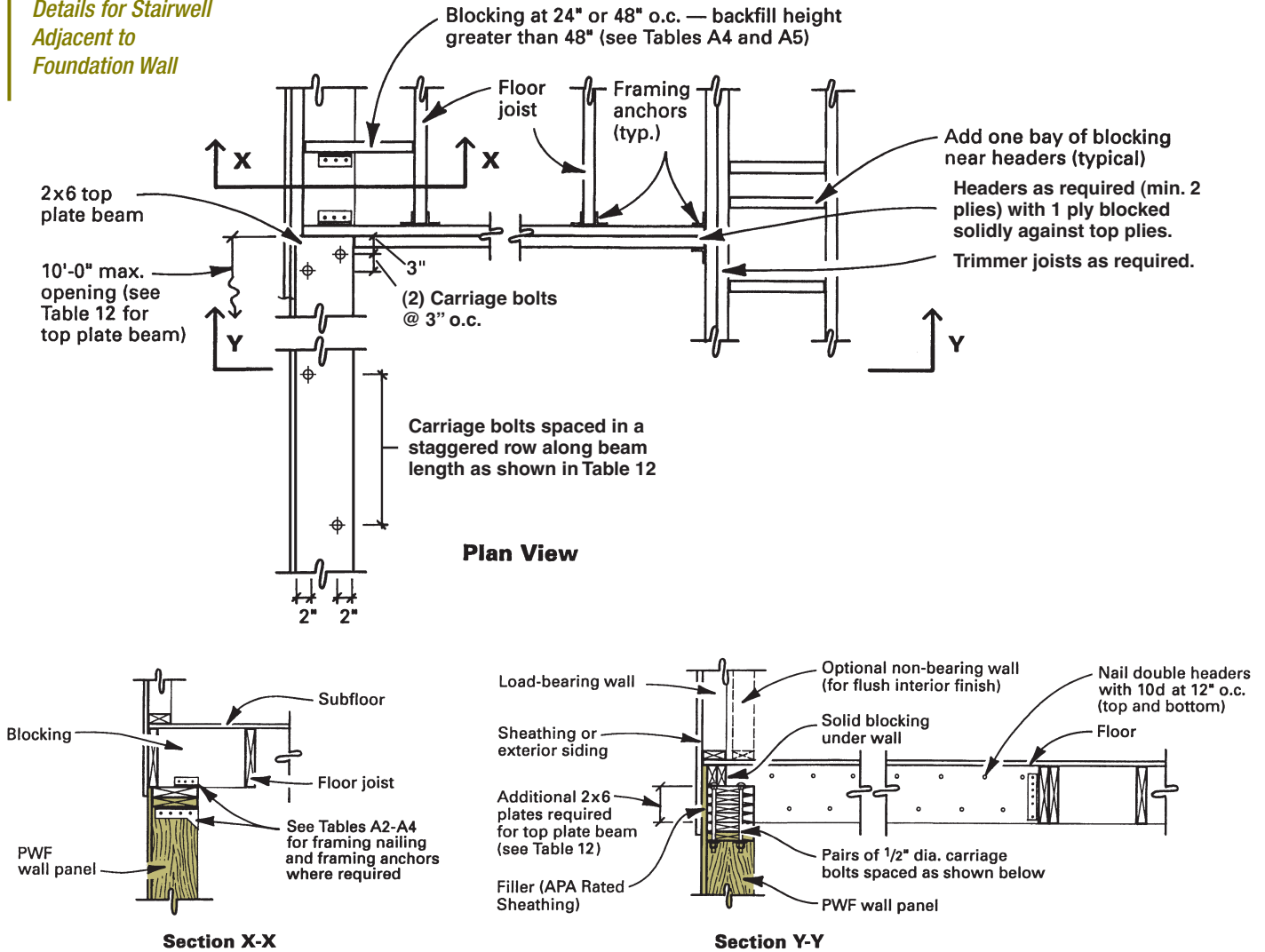


TABLE 12 – STAIRWELL OPENINGS

Backfill Height (inches)	Length of Stairwell Opening (feet)	Size and Number of Additional 2x6 Top Plates Required ¹	Spacing of Carriage Bolts Required along Beam Length ² (in.)
86	10	3	16
	9	2	16
	8 or less	1	24
72	10	1	32
	9	1	32
	8 or less	1	32
60	10	1	32
	9 or less	1	32
48	10 or less	1	32

NOTES:

- (1) For 48" or less backfill height, use standard PWF framing (double top plate continuous with no end butt joints located in stairwell openings); and fasten double headers to PWF top plate with 4-10d toenails.
- (2) For backfill heights greater than 48", refer to Table 12 for top plate beam requirements.

¹ Based on No. 2 Southern Pine lumber. All top plates (including PWF double top plate) continuous with no end butt joints located within stairwell opening. Top plate beam must bear against multiple-ply header joists.

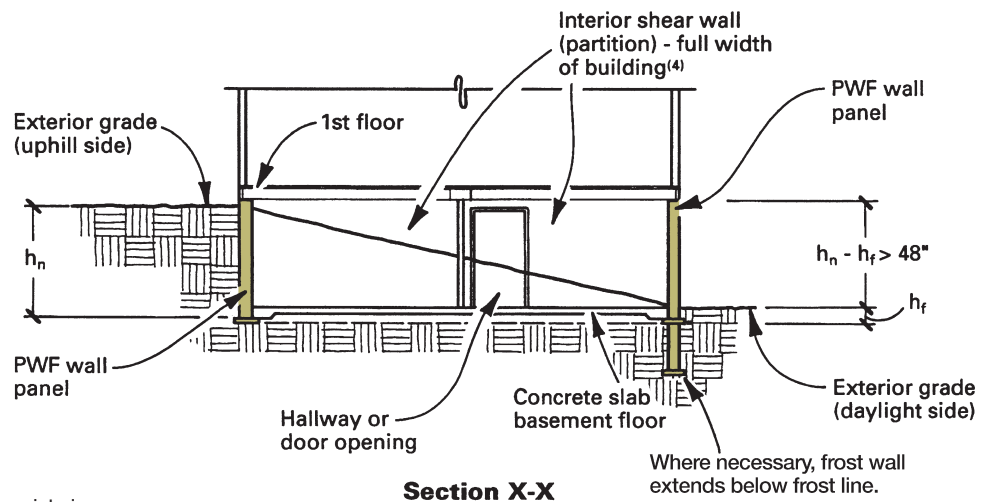
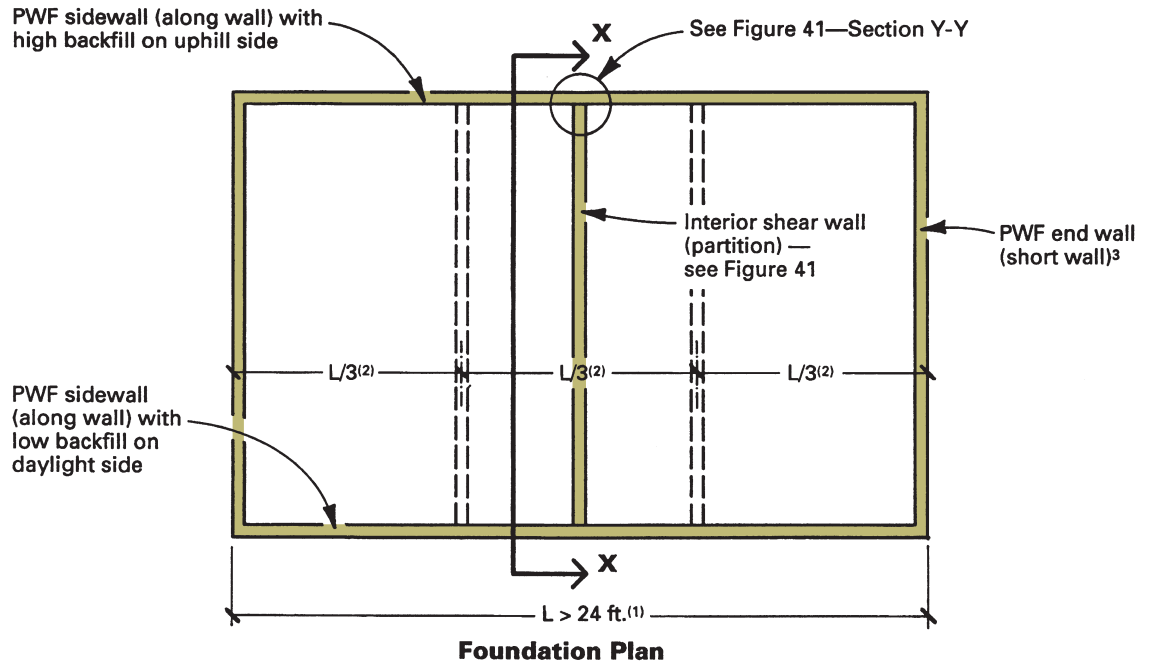
² Locate carriage bolts at both ends of beam and along beam length as shown in **Plan View**.

FIGURE 40

■ PRESSURE-TREATED
SOUTHERN PINE

**Interior Shear Wall
for Daylight Basement
Foundations**

*Differential Backfill Height
More Than 48"*



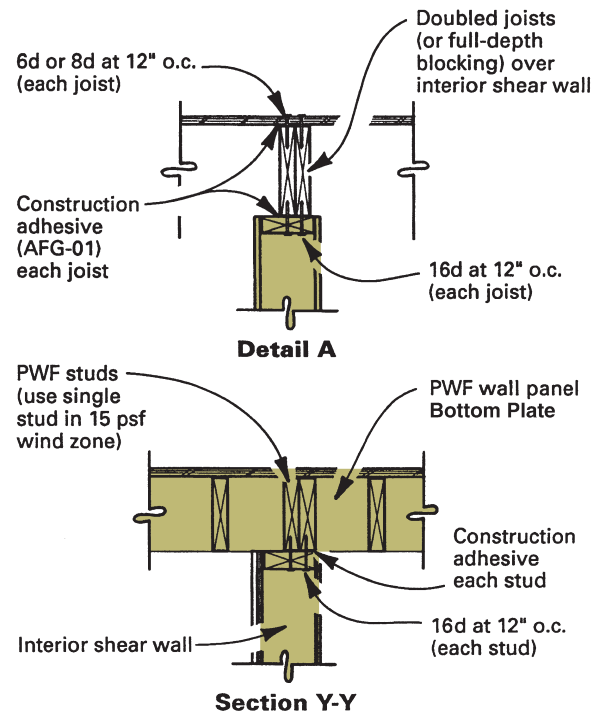
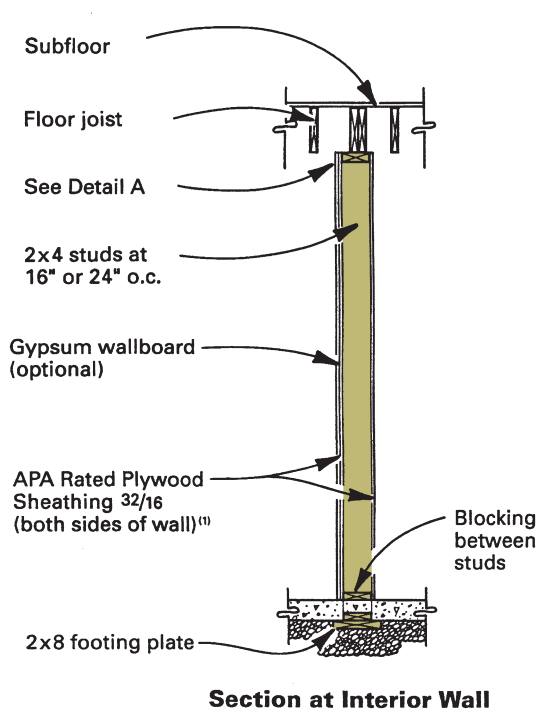
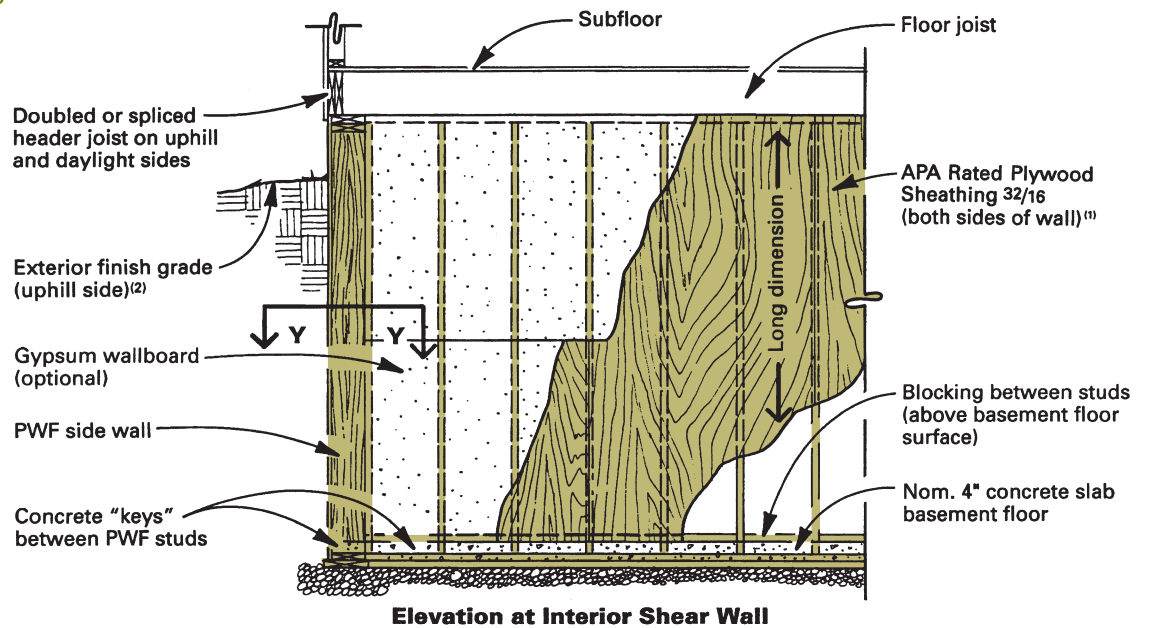
NOTES:

- (1) For buildings with length (L) of 24' or less, interior shear wall is not required.
- (2) For buildings with length (L) from 24' to 48', locate one interior shear wall within middle one-third of building length. For buildings longer than 48', use two or more interior shear walls, equally-spaced (approximately) between PWF end walls. Limit maximum spacing between interior shear wall and PWF end walls, or between interior shear walls, to 24'.
- (3) See Table A1 in Appendix III for plywood foundation sheathing fastener schedule.
- (4) Interior shear wall recommendations based on maximum 4' width opening for door or hallway. Interior shear wall segments may be jogged to accommodate room layouts, but length of individual segments must be at least 8', and total at least 20'.

FIGURE 41

■ PRESSURE-TREATED SOUTHERN PINE

Interior Shear Wall Construction Details for Daylight Basements



NOTES:

- (1) Fasten APA Rated Plywood Sheathing on both sides of interior shear wall. See Table A6 in Appendix III for interior shear wall fastening requirements.
- (2) Complete interior shear wall construction and floor assembly (including concrete slab basement floor and subfloor) before backfilling.

OTHER PWF APPLICATIONS AND RELATED SYSTEMS

PWFs FOR REMODELING

The Permanent Wood Foundation system is as well-suited to remodeling and room additions as it is to new construction. PWFs can be used for room additions with existing building foundations of concrete, masonry, block, or treated wood.

To connect the new foundation to the old, excavate the ground to the level of the footings of the existing foundation. The Permanent Wood Foundation for the new addition can be supported on treated wood footing plates and granular footings as described in this guide, using construction details for stepped footings similar to those shown in Figure 27 where changes in footing levels are necessary. The new PWF sections are connected to the existing foundation using lead expansion shields with 1/2" diameter galvanized lag screws for concrete or masonry foundations, or lag screws into existing treated wood foundation framing. Additional PWF studs may be needed for the existing PWF foundation to fasten the new foundation at the desired location.

PWFs FOR WOOD BASEMENT FLOOR

The Permanent Wood Foundation System is an ideal companion for including a wood basement floor on grade. This system offers the homeowner all the advantages of a conventional wood floor system including enhanced insulation, ease of finishing and a warm, resilient floor. Treated wood members in the basement floor should conform with AWWPA's C-22 Standard (Use Category 4B) for conventional permanent wood foundations. Details for the wood basement floor can be found in Appendix II, pages 44-46 of this publication.

PLEN-WOOD SYSTEM

For crawl-space floors, the Permanent Wood Foundation system is an ideal companion to the Plen-Wood underfloor heating and cooling system. The sealed and insulated underfloor crawl space is used as a plenum chamber to distribute warm or cool air to floor registers in the rooms above. A down-flow forced air mechanical heating/cooling unit maintains air pressure in the plenum to assure uniform distribution of conditioned air throughout the building, with few or no supply ducts. The system saves money because it eliminates ducting and reduces the amount of insulation required. Owners like the system because it produces a more uniform floor-to-ceiling temperature, at lower thermostat settings.

PWFs FOR MANUFACTURED HOUSING

Permanent Wood Foundations are ideal for manufactured homes placed on remote lots. Lightweight foundation sections can be prefabricated and trucked to the site. Once delivered, PWF wall sections can be set in place on gravel or poured concrete footings; for "HUD-code" manufactured (mobile) homes, the chassis is ordinarily placed on stands or piers.

Scheduling problems are virtually eliminated because the foundation can be finished immediately, without waiting for concrete delivery, forming, or curing. The wood foundation can be set in place in almost any weather, even in freezing conditions, so delays are virtually eliminated. Another advantage is that the added support of the load-bearing foundation walls gives the units greater resistance against overturning in high-wind regions. The foundation walls also provide added support, giving the units stronger, stiffer floors.

The permanent wood foundation meets model building code requirements and HUD/FHA requirements for permanent foundations, and is also covered in ANSI/NCSBCS Standard A225.1, for manufactured home installations, published by the National Conference of States on Building Codes and Standards.

FINISHING

An important advantage of the Permanent Wood Foundation is the ease with which the interior and exterior foundation walls can be finished to blend with the rest of the house. On the exterior, wood foundation walls can be overlaid with APA Rated Siding, patterned Southern Pine exterior siding, or other types of code-approved siding to blend with the architectural style of the structure. Wood siding should be at least 6" from the ground.

Exterior foundation walls can also be stained, painted, or covered with a code-approved stucco finish. Film-forming oil-based finishes are not recommended because they tend to crack and flake quickly in areas such as knotholes.

Penetrating semi-transparent oil-based stains generally perform well over CCA-treated plywood. Because they allow some of the wood to show through, the finished color may be affected by the color of the panel surface. If these types of finishes are used, earthtones or a green stain will usually mask any discoloration from the treatment.

Latex solid-color stains or paint systems also show excellent performance over CCA pressure-treated plywood. Earthtones usually provide the best appearance. However, if pastels or white finishes are used, a stain-blocking all-acrylic latex primer, followed by a compatible all-acrylic latex topcoat produces optimum results.

Plywood treated with ACA may contain blotchy deposits of residual surface salts. Thorough brushing to remove these excess surface salts prior to finishing is essential. Because of the blotchy appearance of the ACA treatment, only an all-acrylic latex paint system is recommended. It should be comprised of at least one coat of stain-blocking acrylic latex primer, followed by a companion acrylic latex topcoat. Medium to darker colors are suggested.



APPENDIX I

SELECTION OF LUMBER, PLYWOOD AND FASTENERS FOR A TYPICAL PWF BASEMENT DESIGN

1 *Check soil properties:* See Table 1. This example shows that the soil is Group II and is satisfactory for wood foundations. Group II soils require polyethylene sheeting, and gravel or crushed stone backfill for half the height of total fill against the foundation (see Figure 18). Use sump per Figures 15 or 16.

2 *Select foundation wall framing:* See Table 8. For a one-story house with basement, 36' wide and 86" backfill, use 2x8 studs spaced 16" o.c. No. 2 or higher grade Southern Pine.

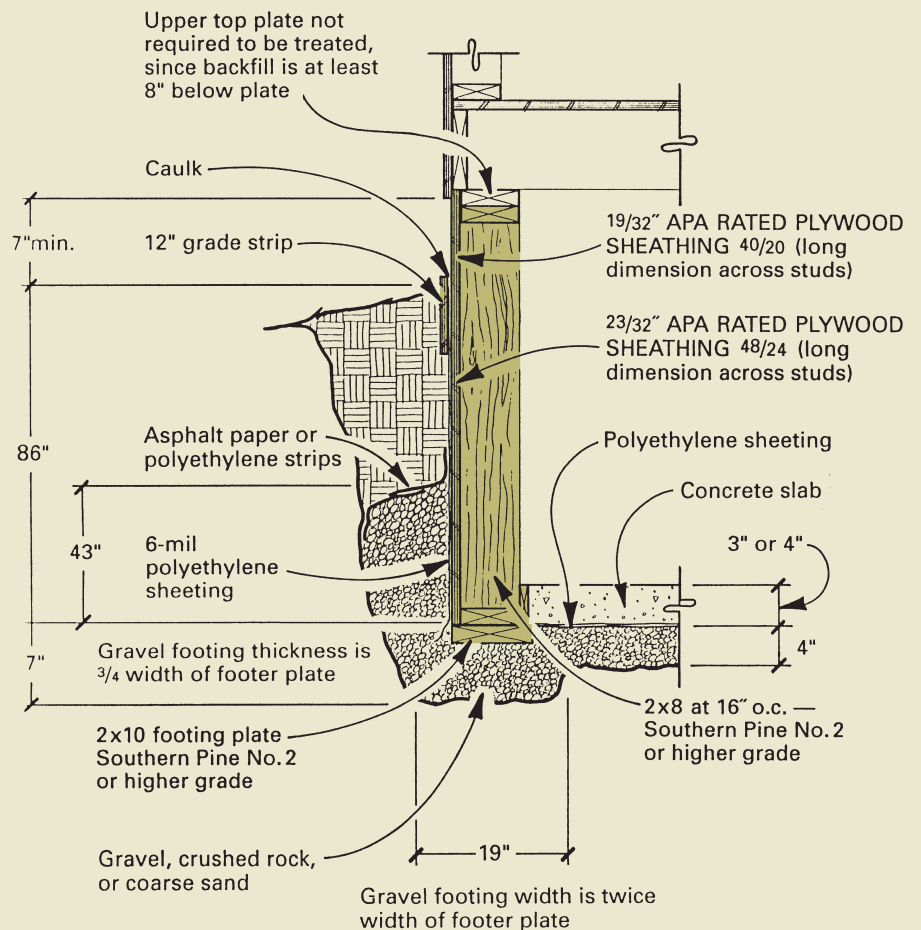
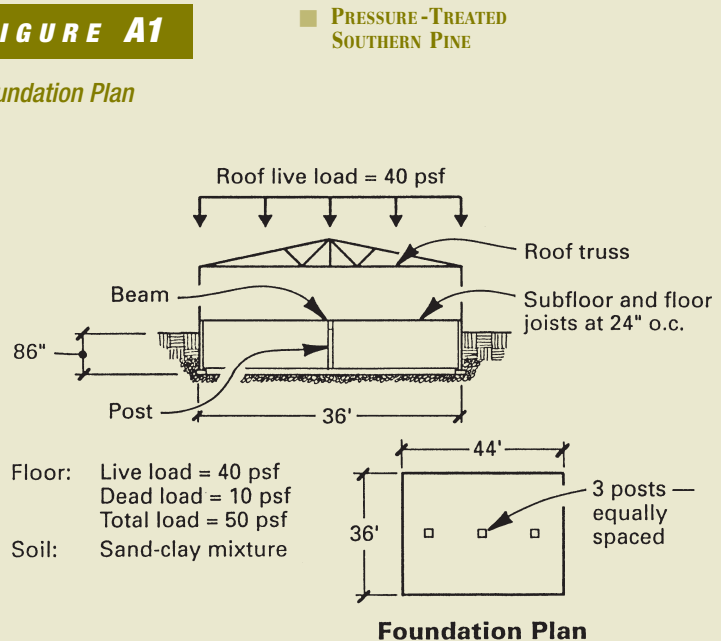
3 *Select footing plate:* See Table 3. For a one-story house with a width of 36', a 2x10 footing plate is required as a minimum, which is appropriate for 2x8 foundation wall studs. Use No. 2 or higher grade Southern Pine.

4 *Select plywood thickness and grade:* See Table 11. For 86" backfill and foundation studs spaced 16" o.c., use: (Lower course) 23/32" APA-RATED SHEATHING 48/24 plywood, long dimension across studs. If panels are not continuous over three stud spacings, provide blocking 16" above bottom plate. (Upper course) 19/32" APA-RATED SHEATHING 40/20 plywood, long dimension across studs. Plywood marked PS1, PS2 or APA Standard PRP-108*, and APA Series V-600 for EXPOSURE 1 or APA Series V-611 for EXTERIOR panels, is recommended.

* NOTE: Use of plywood marked PS2 or PRP-108 should be confirmed per local code requirements.

FIGURE A1

Foundation Plan



5 *Select plywood fasteners:* See Table A1 in Appendix III. Since there is equal backfill around the perimeter, use 16 gauge x 1-1/2 inch stainless steel staples spaced 4" o.c. at panel edges and 8" o.c. at intermediate supports. If 8d stainless steel nails are used, spacing is 6" o.c. at panel edges and 12" o.c. at intermediate supports.

6 *General nailing schedule:* See Table A2 in Appendix III. Note that Table A2 is the minimum nailing schedule and that more or larger fasteners (or framing anchors) may be required, in some cases.

7 *Plate-to-stud and plate-to-plate nailing:* See Table A3 in Appendix II. For 86" backfill, select four 20d end nails in studs and two rows of 10d nails spaced 6" o.c. (each row) to connect the top plates.

8 *Floor-to-joist-to-wall connection:* See Tables A4 and A5 in Appendix II. Table A4 gives joist-to-wall nailing. For 86" backfill height and floor joists spaced 24" o.c., use framing anchor at each joist and blocking member, and toenail header and end joists to top plate with 8d nails spaced 4" o.c. Install blocking spaced 24" o.c. between foundation end walls and floor joists parallel to wall in accordance with Tables A4 and A5.

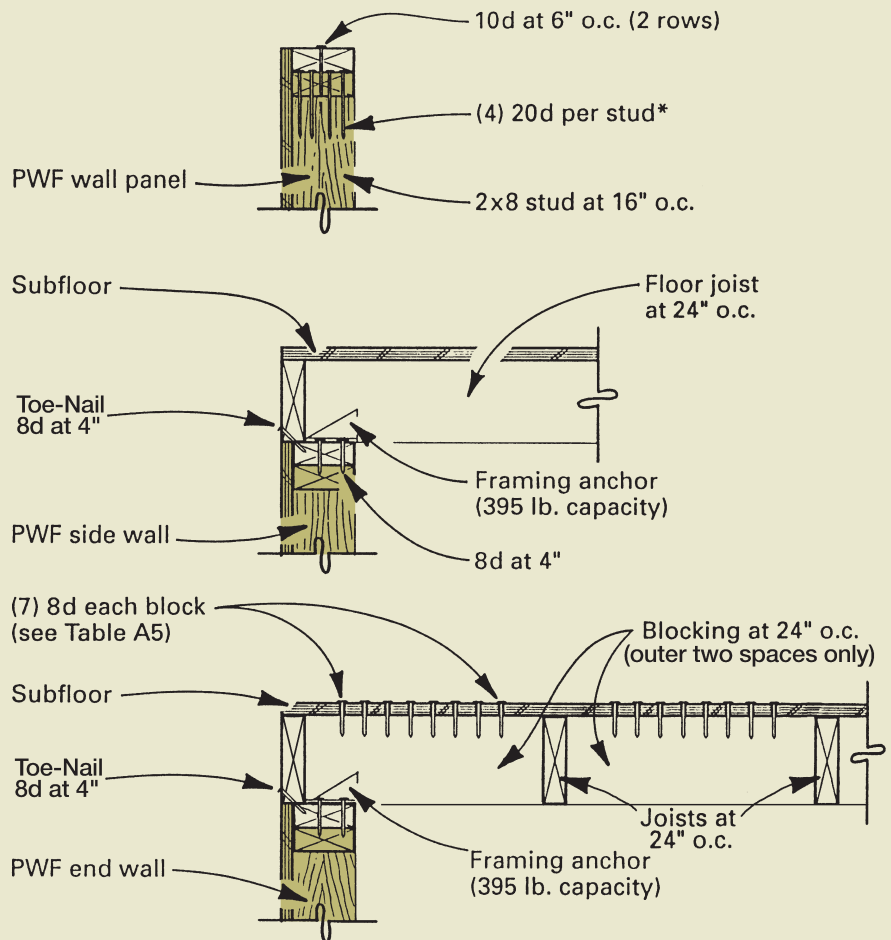
9 *Beam pockets in end walls:* See Table 7, page 21.

10 *Post and piers at center of house:* See Figure 35. These can be the same as the posts and piers used for conventional foundations.

FIGURE A2

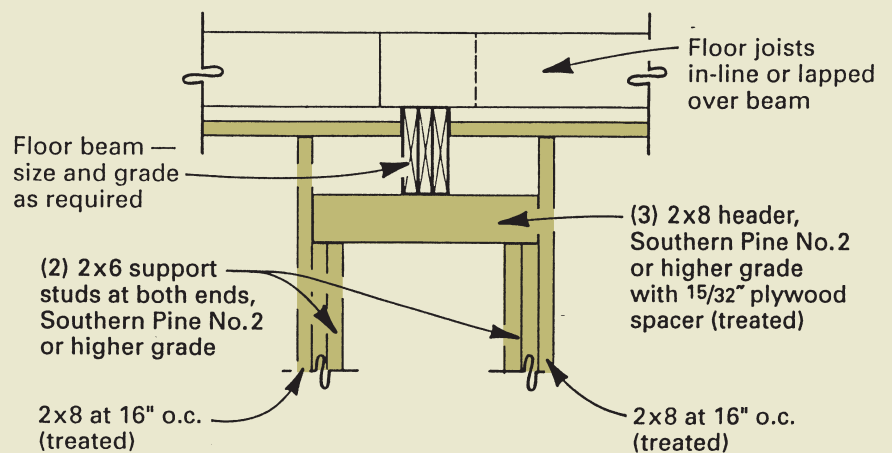
Foundation Plan
continued

■ PRESSURE-TREATED
SOUTHERN PINE



$$\begin{aligned} \text{Contributory floor area} &= \frac{1}{4} \times \text{post spacing} \times \text{width of house.} \\ &= \frac{1}{4} \times 11 \text{ ft.} \times 36 \text{ ft.} = 99 \text{ sq. ft.} \end{aligned}$$

$$\begin{aligned} \text{Load to beam pocket} &= \text{Contributory area} \times \text{floor uniform load} \\ &= 99 \text{ sq. ft.} \times 50 \text{ psf} = 4950 \text{ lb.} \end{aligned}$$



APPENDIX II

WOOD BASEMENT FLOOR DETAILS FOR PERMANENT WOOD FOUNDATIONS

An alternate to concrete slab basement floors used in Connection with the PWF System.

1 These details do not apply to daylight basement applications, except within limitations for equal backfill. (See Detail A).

2 These details are typical. Similar details have been used successfully in residential installations. Wood basement floor is

used in lieu of concrete slab. The floor system must be structurally able to carry thrust from earth pressure on walls. Check with local building officials for acceptance of this system.

3 All material sizes, grades and construction details should be verified by the user and adapted to meet his job conditions.

4 All plywood is to be APA-trademarked.

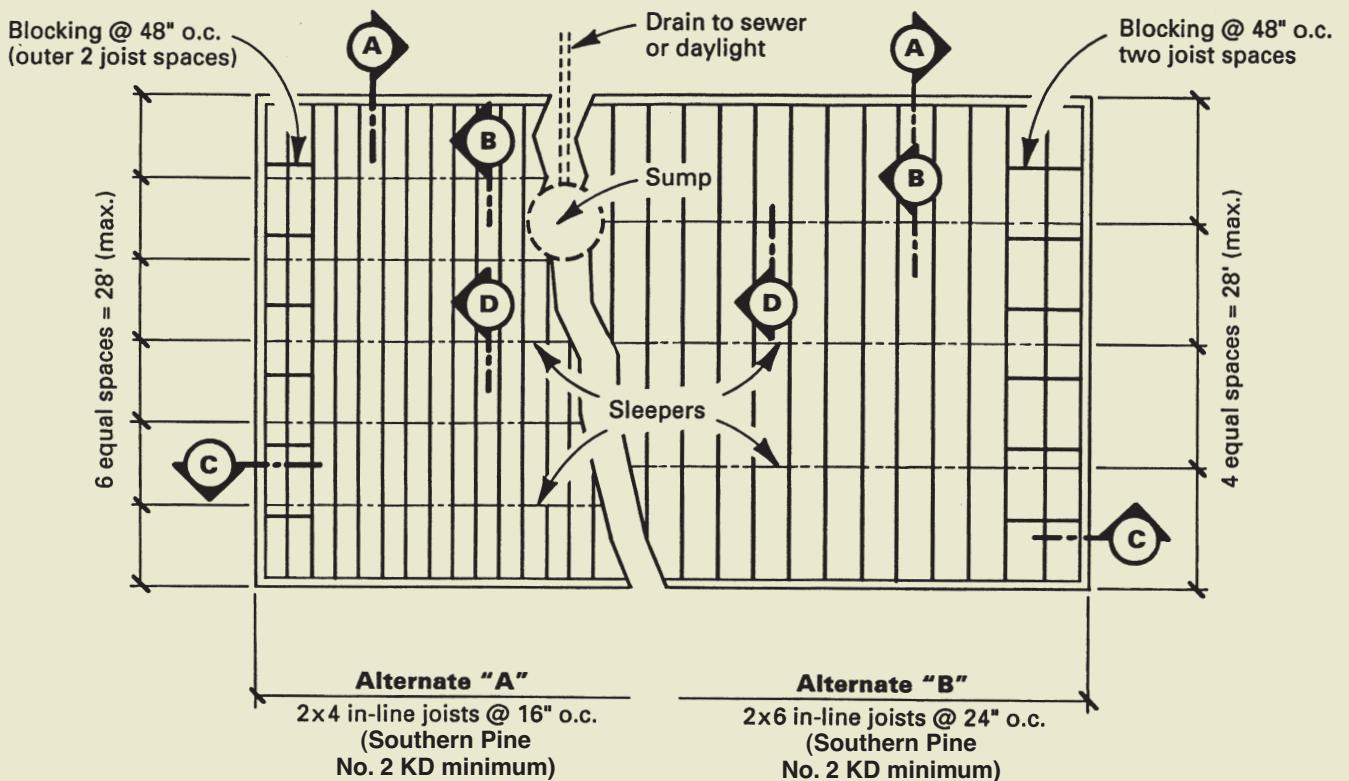
5 Joist sizes and grades are based on a 28' wide house. For other widths, revise design using the "1997 National Design Specification® (NDS) for Wood Construction," published by the American Forest & Paper Association (AF&PA).

FIGURE A3

Floor Framing Plan

■ PRESSURE-TREATED SOUTHERN PINE

Floor Framing Plan



6 Nail plywood subfloor to joists with 6d stainless steel nails, Type 304 or 316, spaced 6" at all supported edges and 10" at intermediate bearings; or 16 gauge x 1-1/2" stainless steel staples spaced 4" at all supported edges and 8" at intermediate bearings. Nail plywood to blocking with 10-8d common stainless steel nails per block. For best performance, nail-glue plywood subfloor to joists using construction adhesive conforming to APA Specifications.

7 For backfill heights more than 72" (86" maximum) or for house widths greater than 28', use Alternate "1" or "2" (p. 46) at Section D to prevent upward buckling of the floor.

8 If floor joists are spaced 16" o.c., use APA RATED SHEATHING 32/16. Use APA RATED SHEATHING 48/24 if joists are 24" o.c. (All-veneer APA RATED SHEATHING plywood marked C-D Exposure 1 is required for this application.)

9 Where a termite hazard exists, treat soil under basement floor and at ground contact points around foundation.

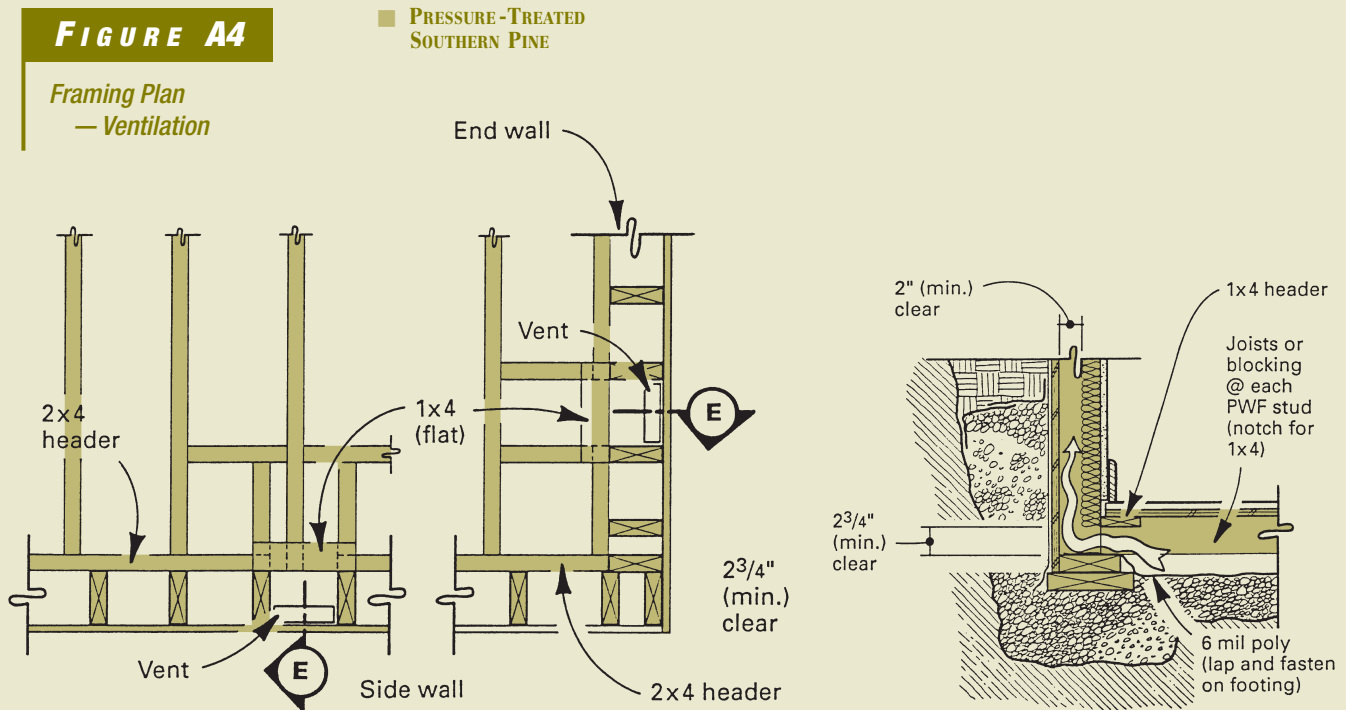
10 Check with local building code for underfloor ventilation requirements. Where ventilation is required, use details below. Details are based on 1,500 sq.ft. floor plan with two vents at each corner.

11 All lumber and plywood used in the wood basement floor is preservative treated to AWPA Standard C-22, (Use Category 5A).

12 For additional details on the PWF system, contact the Southern Pine Council. See page 49.

FIGURE A4

**Framing Plan
— Ventilation**



Framing plan (vent at either end walls or side walls, near corners)

Framing plan — ventilation

NOTE ON VENTILATION:

Check with local building code for underfloor ventilation requirements. Where ventilation is required, use details above. Details are based on 1,500 sq.ft. floor plan with two vents at each corner.

FIGURE A5

■ **PRESSURE-TREATED
SOUTHERN PINE**

Floor Framing

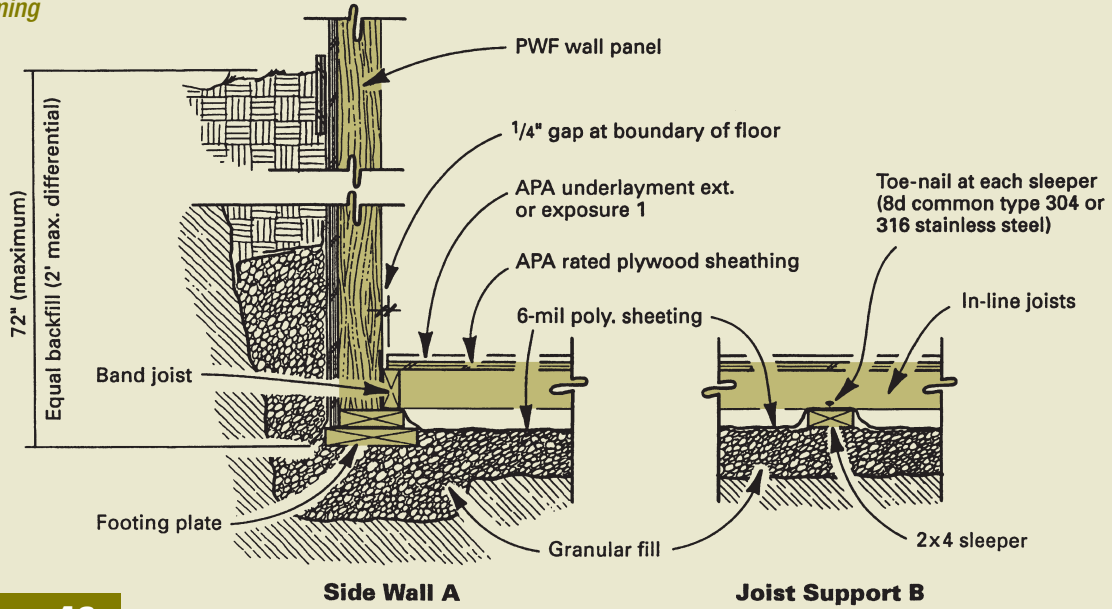


FIGURE A6

Bearing Wall Support

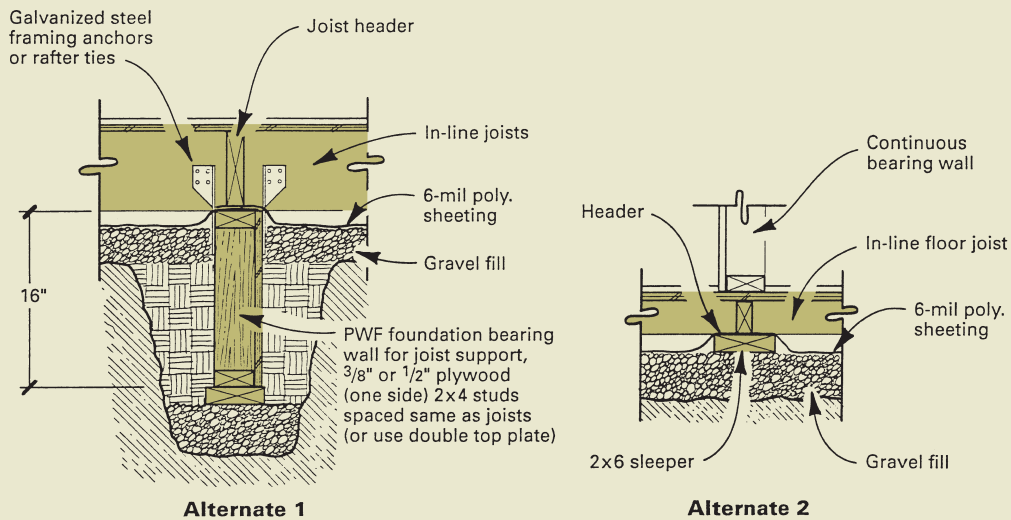
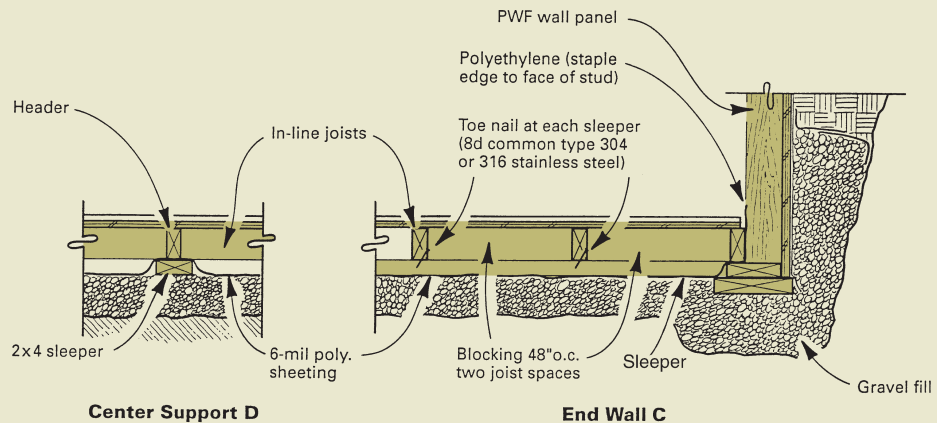


FIGURE A7

Floor Framing Details



APPENDIX III – FASTENER SCHEDULES

TABLE A1 – PLYWOOD FASTENER SCHEDULE FOR PWF¹: USE STAINLESS-STEEL FASTENERS BELOW GRADE²

Fastener	Equal backfill (Max. 2-ft. differential)		Unequal backfill (Max. 6-ft. differential)						
	Panel edges	Intermediate supports	Long walls ³		Short walls				
			Panel edges	Intermediate supports	Number of stories (above foundation)	Number of interior shear walls in basement ⁵	Panel edges ⁴		Intermediate supports
15 psf wind zone	25 psf wind zone								
16 Gauge Staple ⁷	4"	8"	4"	8"	One	None	4"	3"	8"
						One	3"	2"	
						Two	4"	4"	
					Two	None	3"	4" ⁶	
						One	2"	4" ⁶	
						Two	3"	2"	
8d Common Nail	6"	12"	6"	12"	One	None or One	6"	4"	12"
						Two	6"	6"	
					Two	None or One	4"	3"	
						Two	6"	4"	

- In crawl space construction, provide a fastener within 1-1/2" of the bottom of each stud.
- In above-grade areas, hot-dipped or hot-tumbled galvanized steel, silicon bronze or copper nails may also be used.
- Schedule applies when backfill on one long wall is higher than on the opposite one. When backfill is higher on one short wall than on the opposite one, use the schedule from the "Short wall" columns for the long walls, but for a length at least equal to one-half the length of the short wall. Then the "Long wall" schedule applies to the rest of the long walls, and all of the short walls.
- Fasten all panel edges to 2-inch nominal framing or blocking.
- See Figure 40 for guidelines on determining interior shear wall requirements.
- Install APA Rated SHEATHING 32/16 plywood on both sides of PWF end walls (short walls).
- Minimum 1" penetration into framing.

TABLE A2 – GENERAL NAILING SCHEDULE

Joint Description	Minimum Nail Size ¹	Number or Spacing
Bottom plate to footing plate – Face nail	10d	12" o.c.
Bottom plate to stud – End nail – 2" plate	16d	2
– 1" plate	8d	2
Top plate to stud – End nail minimum (See Table A3)	16d	2
Upper top plate to top plate – Face nail minimum (See Table A3) (No overlap of plywood)	10d	8" o.c.
Header joist to upper top plate – Toe nail minimum (See Table A4)	8d	16" o.c.
Joist to upper top plate – Toe nail minimum (See Table A4)	8d	3
End joist to top plate (joists parallel to wall) – Toe nail minimum (See Table A4)	10d	2
	8d	4" o. c.
Plywood flooring to blocking at end walls (See Table A5)	–	–
Window header support studs to window sill – End nail minimum	16d	2
Window sill to studs under – End nail minimum (See Table A3)	16d	2
Window header to stud – End nail	16d	4
Knee wall top plate to studs – End nail	16d ²	2
Knee wall bottom plate to studs – End nail	8d ²	2
Knee wall top plate to foundation wall – Toe nail	16d ²	1 per stud
Knee wall stud over 5' long to foundation wall stud – Toe nail at mid-height of stud	16d ²	2 per stud
Knee wall bottom plate to footing plate – Face nail	8d ²	2 per stud space
Window, door or beam pocket header support stud to stud – Face nail	10d	24" o.c.
Corner posts – stud to stud – Face nail	16d	16" o.c.

- Heavy loads may require more or larger fasteners or framing anchors. All lumber-to-lumber fasteners below grade may be hot-dipped or hot-tumbled galvanized, except as noted.
- Stainless-steel nails required.

TABLE A3 – MINIMUM NAILING SCHEDULES: TOP PLATE-TO-STUD AND PLATE-TO-PLATE CONNECTIONS¹

Height of Fill (inch)	End-nail treated top plate to treated studs		Face-nail untreated top plate to treated top plate			
			No overlap of plywood		3/4" (min.) plywood overlap	
	Nail Size ²	Number per Joist	Nail Size ²	Spacing (inch)	Nail Size ²	Spacing (inch)
24	16d	2	10d	8	10d	16
48	16d	2	10d	8	10d	16
72	16d ³	3	10d	6	10d	8
86	20d ³	3	10d	3 ⁴	10d	4 ⁴

- 1 Based on 30 pcf equivalent-fluid density soil pressure and dry Southern Pine lumber.
- 2 Hot-dipped, hot-tumbled or stainless-steel common wire nails.
- 3 Alternatively, may use "U" type framing anchor or hanger with nails and steel plate meeting requirements of DFI (see 2.4) and having a minimum load capacity (live plus dead load, normal duration) of 340 pounds in Southern Pine lumber.
- 4 Alternatively, two nails 2-1/2 inches apart across the grain at twice the spacing indicated may be used.

TABLE A4 – MINIMUM NAILING SCHEDULES: FLOOR JOISTS TO WALL CONNECTIONS¹

Height of Fill (inch)	Joist Spacing (inch)	Joists Perpendicular to Wall				
		Toe-Nail ² Header Joist to Plate		Toe-Nail ² each Joist to Plate		Framing Anchor ^{4,9} each Joist to Plate
		Nail Size ⁵	Spacing (inch)	Nail Size ⁵	Number per Joist	
48 or less	16	8d	16	8d	3	none
		10d	16	10d	2	none
	24	8d	8	8d	3	none
		10d	8	10d	2	none
72	16	8d	8	8d	3	none
		10d	8	10d	2	none
		8d	16	none	none	1 ⁶
	24	10d	8	10d	3	none
		8d	16	none	none	1 ⁶
86	16	8d	8	none	none	1 ⁷
	24	8d	4	none	none	1 ⁸

Height of Fill (inch)	Blocking ³ between joists, spacing (inch)	Joists Parallel to Wall				
		Toe-Nail ² End Joist to Plate		Toe-Nail ² Blocking to Plate		Framing Anchor ⁴ each Block to Plate
		Nail Size ⁵	Spacing (inch)	Nail Size ⁵	Number per Block	
48 or less	No Blocking	8d	4	none	none	none
72	48	8d	4	8d	3	none
		10d	4	10d	2	none
		10d	6	10d	4	none
		8d	6	none	none	1
86	24	8d	4	none	none	1

- 1 Based on 30 pcf equivalent-fluid density soil pressure and dry Southern Pine lumber.
- 2 Toe-nails driven at angle of approximately 30° with the piece and started approximately one-third the length of the nail from the end or edge of the piece.
- 3 See Table A5 for additional spacing requirements for blocking, and for subfloor to blocking nailing schedule.
- 4 Framing anchors shall have a minimum load capacity (live load plus dead load, normal duration) of 320 pounds in Southern Pine lumber.
- 5 Common wire steel nails.
- 6 Provide one framing anchor with two 8d nails per flange.
- 7 Provide one framing anchor with five 8d nails per flange.
- 8 Provide one framing anchor with eight 8d nails per flange.
- 9 Framing anchors can be angles, straps, or hinges.

Typical Fastening – Foundation End Walls to Floor System

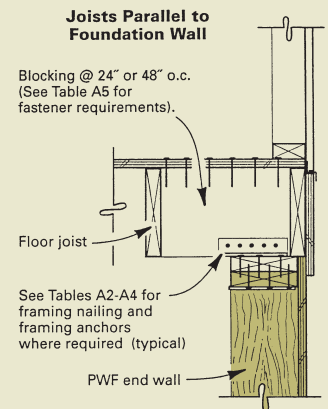


TABLE A5 – MINIMUM NAILING SCHEDULES: SUBFLOOR TO END WALL BLOCKING^{2,3}

Height of Fill (inch)	No. 2 or higher grade Southern Pine		
	Blocking Spacing (inch)	Nails per Block ¹	
		6d	8d
60	48	4	3
72	48	8	6
	24	3	2
86	24	7	5

- 1 Common wire nails. Nails shall be spaced 2 inches o.c. or more; where block length requires, nails may be in two rows.
- 2 See Table A4 for additional requirements for spacing and nailing of blocking.
- 3 Based on 30 pcf equivalent-fluid density soil pressure and dry lumber.

TABLE A6 – FASTENER SCHEDULE FOR SHEATHING ON INTERIOR SHEAR WALLS FOR DAYLIGHT BASEMENT CONSTRUCTION¹

Fastener	Number of Stories (Above Foundation)	Number of Interior Shear Walls in Basement	Panel Edges		Intermediate Supports
			15 psf Wind Zone	25 psf Wind Zone	
8d Common Nail	One	One	4"	3"	12"
		Two	4"	4"	
	Two	One	3"	–	
		Two	3"	–	
10d Common Nail	Two	One	–	2" ^{2,3}	12"
		Two	–	3" ³	

- 1 Install APA RATED SHEATHING 32/16 plywood on both sides of interior shear walls (see Figure 41). Fasten all panel edges to 2-inch nominal framing or blocking.
- 2 APA STRUCTURAL I RATED SHEATHING 32/16 plywood required for this application.
- 3 Use 3-inch nominal or wider framing at panel edges, and stagger nails.

ADDITIONAL INFORMATION

The Southern Pine Council offers a wide variety of other publications to help you use Southern Pine lumber properly. A single copy is available free upon request. Builders, designers, specifiers and users can benefit from materials that include:

Facts About Permanent Wood Foundations

a wood industry response to claims by the concrete industry, 12 pages (#401, \$1)

A Home Buyer's Guide to the Permanent Wood Foundation

design details, advantages, 8 pages (#402, \$1)

Your First Look: The Permanent Wood Foundation System

basics of the system, advantages, acceptances, 2 pages (#405, .25)

Southern Pine Use Guide

design values, grade descriptions, sample specifications (#200, \$2)

Maximum Spans: Southern Pine Joists & Rafters

span tables, design criteria, 36 pages (#202, \$2)

Southern Pine Headers & Beams

size selection and allowable load tables for Southern Pine lumber and glued laminated timber, 36 pages (#207, \$2)

Southern Pine Floor Trusses

design flexibility, span comparisons, 4 pages (#218, .50)

Pressure-Treated Southern Pine

retentions, standards, proper use & handling, 20 pages (#300, \$2)

APA Technical Note K830-Termite Protection for Wood-Framed Construction

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USDA Forest Products Laboratory; Madison, Wisconsin

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The content of this publication has been compiled by the Southern Forest Products Association (SFPA) on behalf of the Southern Pine Council (SPC) as a service to buyers, users, and specifiers of wood building materials. The council is a nonprofit trade promotional group supported by Southern Pine lumber manufacturers. One of the primary missions of the council is to provide information to those interested in the industry's products. SFPA neither grades, tests, manufactures, nor treats lumber products.

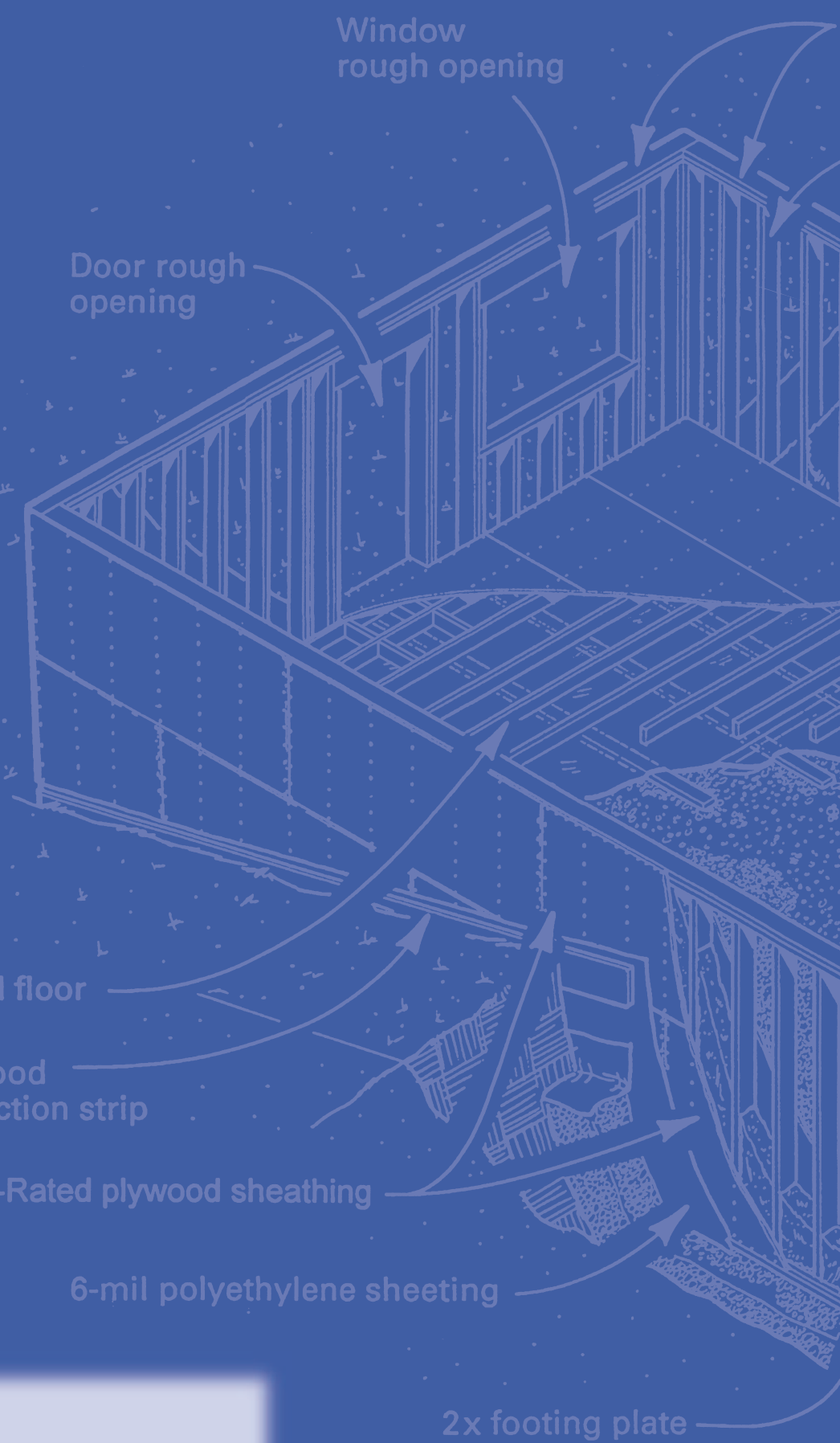
The technical information in this publication did not originate with SPC. Information pertaining to Southern Pine design values, moisture content requirements and spans is based on the *Standard Grading Rules for Southern Pine Lumber, 1994 Edition*, published by the Southern Pine Inspection Bureau (SPIB). Information about pressure-treating methods and performance of lumber products is based on the approved standards of the American Wood Preservers' Association (AWPA).

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Window rough opening

Door rough opening

Wood floor

Plywood protection strip

APA-Rated plywood sheathing

6-mil polyethylene sheeting

2x footing plate



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