

POST-FRAME BUILDING FOUNDATION OPTIONS

SUMMARY:

Many people believe the foundations of all post-frame buildings (sometimes referred to as “pole buildings” or “pole barns”) consist of treated wood posts embedded in the ground. In reality, post-frame buildings can be supported by a variety of foundation types. Ten such foundation options are presented to provide builders and design professionals with information they need to meet the highest demands for quality, durability and sustainability.

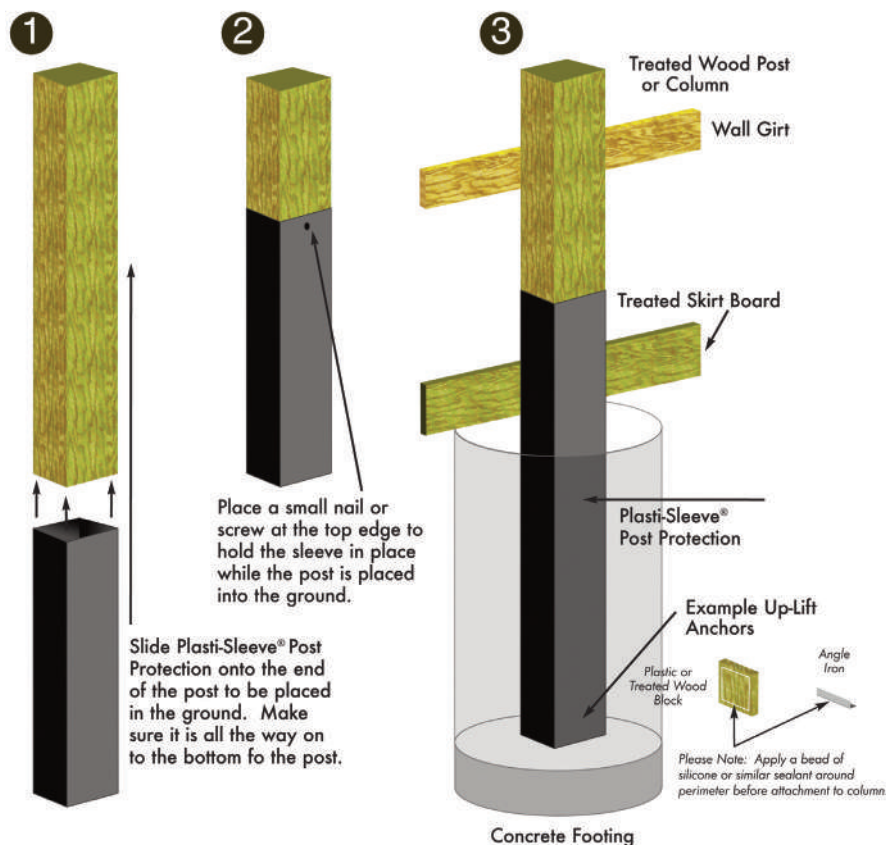
Post-frame buildings are economical, energy-efficient and environmentally friendly buildings that may use a wide variety of finish options to suit most low-rise commercial, industrial, retail, residential and public purposes. Traditional post-frame foundations use soil-embedded wood posts or laminated columns in accordance with the standards of the American Wood Protection Association (formerly the American Wood-Preservers’ Association). A report created by the Forest Products Lab of the U.S. Department of Agriculture offering predictions of typical service life for southern pine posts using different treatments has been published by AWP (Freeman et al., 2005).

Many people do not realize that soil-embedded pressure preservative-treated wood posts are not the only foundation option for post-frame buildings. Post-frame buildings are commonly supported by other foundation systems. Following is a brief description of some of these other foundation options.

FOUNDATION OPTION 1: Treated Wood Post or Column with Plastic Barrier System

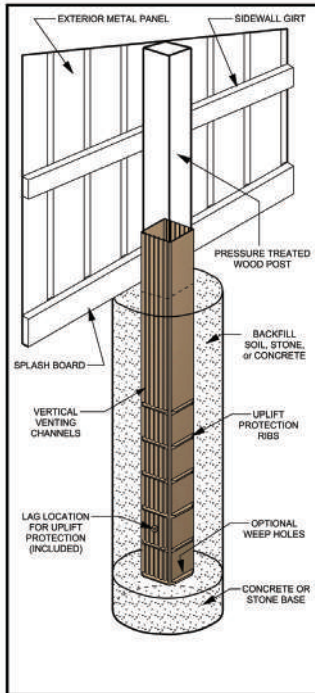
A plastic barrier system (Figures 1a, 1b, 2a, 2b) may not form a seal that is

TYPICAL POST FRAME DESIGN



FIGURES 1a AND 1b.

Plastic barrier system employing blow-molded high-density polyethylene 0.080-inch thick (Source: David Gruhlke)



FIGURES 2a AND 2b. Plastic barrier system employing blow-molded HDPE 0.090-inch thick (Source: Ken McDonnell)

completely impervious to moisture and other environmental factors, thus requiring the use of preservative-treated wood for in-ground applications. The barrier system provides the means by which an in-ground post has little or no ground contact, and it reduces chemical leaching into the environment. Research by Scheffer and Morrell (1997) has shown that both treated and untreated wood in soil contact will last longer if covered with as little as two-mil-thick polyethylene film. In Scheffer and Morrell's study, polyethylene boots were placed on both untreated and low-retention treated stakes prior to insertion into the soil. No attempt was made to keep water from entering the upper, open end of the boots. The boots retarded attack, even on untreated stakes, by serving as an additional layer of protection against the decay fungi. Barnes and colleagues (2013) also found that the longevity of treated wood embedded in soil is increased when plastic barrier systems are used. Uplift resistance may be addressed in different ways; for example, by (a) boring a hole through the bottom of the post and sleeve and inserting a piece of rebar that is then encased in a concrete collar; (b) affixing plastic, wood or composite blocks or galvanized angle iron on the sides of the bottom of

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the post; (c) using four or more 1/4 inch x 2 inch double-hot-dipped galvanized lags with ethylene propylene diene monomer (M-class) rubber-bonded washers to secure a barrier that features integral uplift resistance ribs. Sealing of fastener penetrations may be recommended in some instances, or weep holes may be added to the bottom of the sleeve. Some barrier systems may cover only the area of the post near the soil surface that is most prone to decay and not extend all the way to the bottom of the post.

FOUNDATION OPTION 2: Treated or Untreated Wood Post or Column with a Wood Encapsulation System

Unlike the aforementioned plastic barrier systems, plastic barrier systems that encapsulate wood (Figures 3, 4) keep the covered portion of the wood completely out of contact with outside oxygen and moisture. Because encapsulation systems are airtight and watertight, chemical treatment may be optional for soil-embedded wood foundations within interior wall spaces. Research by Barnes and colleagues (2013) led to the creation of a unique AWP specification category, “Barrier Protection Systems,” that may not require chemical wood treatment. To create an encapsulation system as shown in Figure 3, posts are first notched at the base to create a contour that a cast-in-place concrete collar can adhere to. Then an airtight and watertight modified bitumen membrane similar to commercial-grade roofing membranes is applied. A polyurethane barrier at least 0.30 millimeter thick as specified in International Code Council ESR-1834 is then wound over the modified bitumen to protect it from damage and ensure complete encapsulation. Finally, the covered portion of the wood is placed in a specially designed oven for curing, and the high temperature destroys microorganisms that cause decay (Figure 3).

FOUNDATION OPTION 3: Cast-In-Place Concrete Piers

Concrete piers formed at each post location with a heavy steel bracket to



FIGURE 3. Automated application of an impermeable bitumen with ethylene propylene diene monomer encapsulation system. (Source: Barry Hoffman)

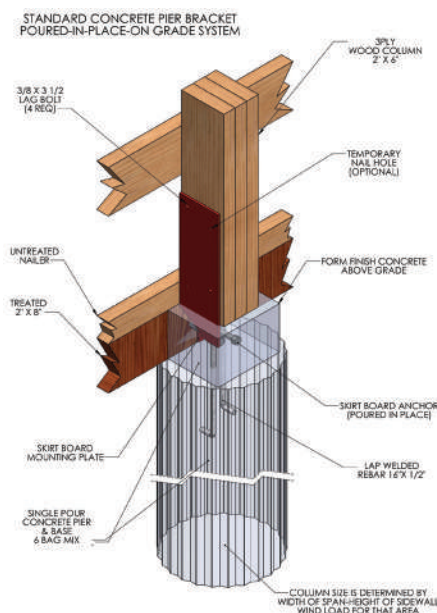


FIGURE 5. A cast-in-place concrete pier that uses a bracket attached to a grade girt while concrete is poured under the bracket (Source: Jack Cutforth)

provide lateral shear and uplift resistance will elevate posts above the soil, as seen in Figure 5. As illustrated in Figure 6, brackets may be jigged in place using the grade girt, stakes or other methods to hold the bracket in place while concrete is added within the form underneath to support the post bracket. Alternatively, some brackets may also be wet-set by fill-

FIGURE 4. Illustration of finished product on a post that has been notched to ensure adhesion to a concrete collar. (Source: Barry Hoffman)



FIGURE 6. This cast-in-place pier uses a bracket that can either be wet-set into a form filled with fresh concrete or jigged in place for concrete to be poured underneath it. (Source: Brandon Meyer)

ing a forming tube with freshly mixed concrete and inserting anchors or rebar affixed to a bracket. Some post-frame buildings built on concrete piers may also use a cast-in-place concrete floor, a raised floor system or a dirt or gravel floor. Depending on the shear strength of the steel brackets, additional lateral bracing may be required.

FOUNDATION OPTION 4: Precast Concrete Piers

Precast concrete piers (Figure 7) are manufactured off site, so their use is not impacted by weather, transportation or other conditions that influence the use of cast-in-place concrete. Precast concrete piers for post frame must be properly engineered and tested and may be licensed to manufacture under patent. Wood posts or laminated wood columns may be attached to precast piers before they are placed in holes and plumbed like a post in the ground as shown in Figure 8, or the piers may be placed in soil first so wood posts or entire wall assemblies may be tilted into place. Uplift resistance is typically provided using galvanized angle iron or rebar set in a concrete collar.

FOUNDATION OPTION 5: Traditional Spread-Footing Frost Wall

Many consumers and design professionals are unaware that post-frame buildings may be erected upon a traditional foundation wall (Figure 9). A

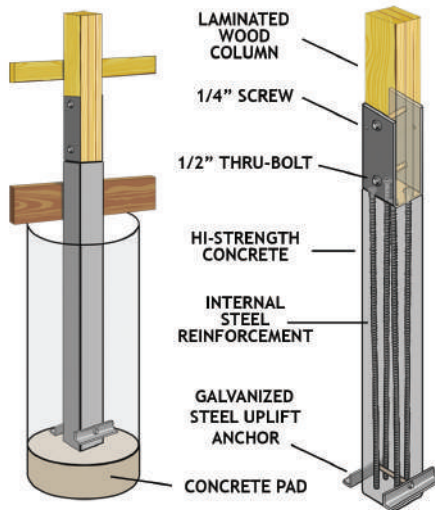


FIGURE 7. A precast concrete pier assembly. (Source: Brandon Meyer)

spread-footing frost-wall system typically is formed with two pours, one in the bottom of a trench to widen the footprint and carry heavier loads, followed by the formation of a narrower wall form to extend from the top of the spread footing to one foot or more above grade. This type of foundation may be required for some types of structures in various localities but still allows for an efficient and economical post-frame design.

FOUNDATION OPTION 6: Traditional Trench Wall

Post-frame structures have, by nature, small footing foundation loads compared to most other building designs. The relatively small footing loads make a



FIGURE 8. Precast concrete piers attached to wood posts and plumbed like a wood post set in soil. (Source: Robert Meyer)

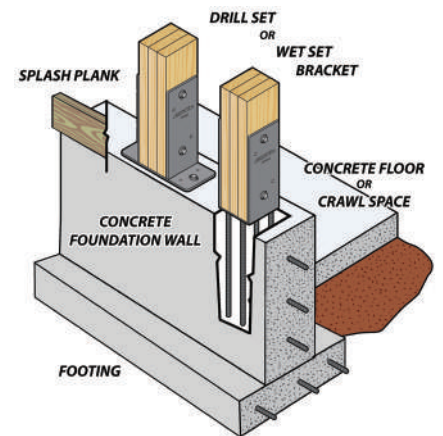


FIGURE 9. A typical spread-footing or frost-wall foundation using a wet-set or drill-set bracket. (Source: Brandon Meyer)

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spread-footing frost wall unnecessary in many cases unless it is required by a local code or the post-frame structure is atypically wide. A simple one-pour trench wall (Figure 10) may extend below the frost line to provide a continuous concrete foundation that will distribute loads around the perimeter of the entire building.

FOUNDATION OPTION 7: Frost-Protected (Insulated) Slab /Frost-Protected Shallow Foundation

International Residential Code (IRC) Section 402.2.8: Slab-on-Grade Floors (illustrated in IRC 2003, Figure R403.3[1], p. 69) dictates an acceptable method to create a foundation that does not extend below the frost line. The IRC illustrates this method of insulating a concrete slab with insulation extending one foot below the soil and then extending one foot horizontally at a depth of one foot below grade. This effectively keeps frost from penetrating below a thickened-edge slab. Several options are available, depending on the situation, as described in Figure 11 (see also Bohnhoff, 2010).

FOUNDATION OPTION 8: Concrete Piers with Grade Beam

Continuous concrete foundations may be required in some localities for commercial or residential structures. To meet requirements for a continuous concrete foundation while using the least amount of concrete, concrete piers can extend the load-bearing elements below frost depth, while a ribbon or grade beam (Figure 12) spans between to deter rodents and insulation around the grade beam prevents frost from affecting the grade beam and penetrating the building envelope. Extruded polystyrene insulation boards may be used as wing insulation parallel to the bottom of the grade beam (minimum 12 inches deep), and perimeter insulation is placed vertically along its outside; or the insulation boards may simply extend downward past the grade beam (typically 24 inches deep). This may reduce concrete cast in place by about one-half to two-thirds compared

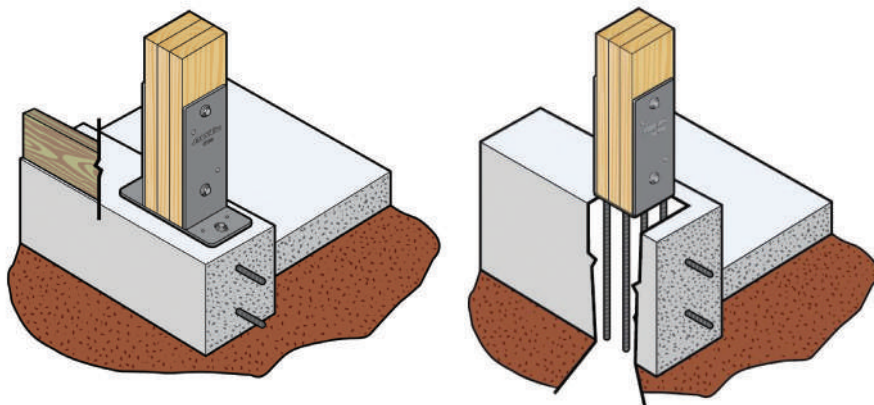


FIGURE 10. A traditional trench wall using wet-set and drill-set brackets; the depth of the trench must meet local frost-depth requirements. (Source: Brandon Meyer)

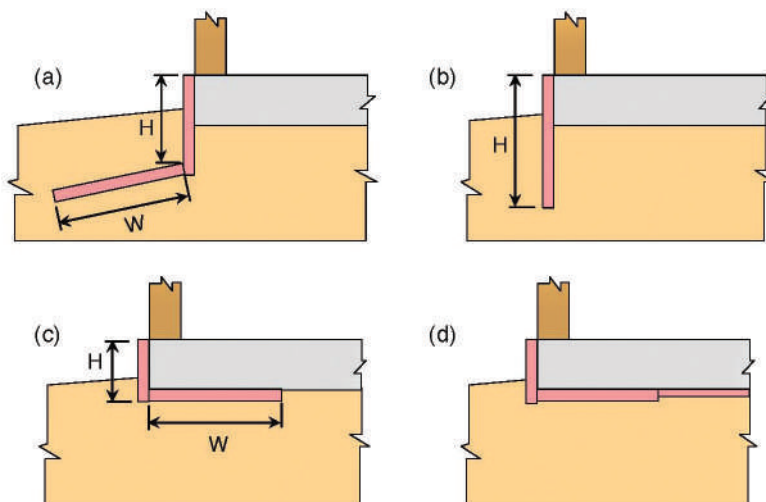


FIGURE 11. Below-grade insulation options for a concrete slab-on-grade: (a) vertical and horizontal wing insulation for heated buildings; (b) vertical insulation only for heated buildings that may extend as much as twice as deep in soil than if wing insulation is not used; (c) insulation on outside and underside of perimeter edge for unheated building to prevent structural heaving; and (d) insulation on the outside edge and entire underside of slab to prevent both structural and floor heaving. (Bohnhoff, 2010).

to a spread-footing foundation, making it the least expensive continuous concrete foundation option.

FOUNDATION OPTION 9: Basement Walls

Just like most other framing systems, a post-frame building can be placed on a basement wall designed for post point loads, as illustrated in Figure 13. This is facilitated by using the same post-to-concrete attachment methods used with a cast-in-place frost wall or pier. Wet-set or drill-set brackets may



FIGURE 12. Precast concrete piers with a grade beam (Source: Robert Meyer). A detail showing precast concrete piers with a grade beam or "ribbon" may be downloaded from <http://bit.ly/1BMdgNG>.



FIGURE 13. Illustration of a post anchored to a concrete basement wall with a drill-set bracket. (Source: Brandon Meyer)



FIGURE 14. A helical screw pile. (Source: Frame Building News)



FIGURE 15. A specialized mini-excavator attachment for screw pile installation. (Source: *Frame Building News*)

be mounted on a traditional basement wall. Alternatively, a partial basement or storm shelter may be inset from a building that uses ground-embedded posts or concrete piers.

FOUNDATION OPTION 10: Screw-Pile Foundations

In the January 2013 issue of *Frame Building News*, Alan J. Lutenege, PhD, PE, professor of civil and environmental engineering at the University of Massachusetts, published an article on

helical screw piles. Lutenege (2013) specifies that piles range from 4 to 10 feet in length and about 4½ inches to 10¾ inches in diameter, with a single helical blade 10–16 inches in diameter (**Figure 14**). Approximate installation time for a five-foot screw pile may range from five to eight minutes (**Figure 15**). Screw piles offer immediate load-transfer capability and minimal installation noise, vibration, site disruption, soil cuttings and cleanup. Screw piles can be rapidly installed in tight areas at a low cost without highly specialized equipment.

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Conclusion

Many people believe that all post-frame buildings are characterized by pressure-preservative-treated posts embedded in soil. Although this is the most common foundation option for post-frame buildings because of its economy and speedy installation, it is not the only one. Ten unique foundation options have been identified for post-frame buildings. As technology and innovations continue, we should expect more in the future.

John Fullerton is president of Heartland Perma-Column. As the former executive vice president of the National Frame Building Association, he authored a series of articles called "The Post-Frame Advantage" for Frame Building News as well as the hardbound Post-Frame Advantage Handbook and other materials for NFBA. He can be reached at john@hlandpc.com and 785.594.5696.

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References

- Barnes, H. M., Sanders, M. G., Lindsey, G. B., & McIntyre, C. R. 2013. Barrier systems redux. *Proceedings*, American Wood Protection Association annual meeting, Honolulu, HI, April 28–May 1, 2013, vol. 109, 52–60. Birmingham, AL: American Wood Protection Association.
- Bohnhoff, D. R. 2006, January. Post frame: As green as it gets. *Frame Building News*, 18(1), 64–65.
- Bohnhoff, D. R., 2008a. *Engineering Design Manual for Series 6300, 6400, 8300, 8400 Perma-Columns*. Unpublished technical report. Madison, WI: University of Wisconsin–Madison.
- Bohnhoff, D. R. 2008b. Twelve structural applications for post-frame. *Frame Building News*, 20(3), 34–45.
- Bohnhoff, D. R. 2010. Below-grade insulation for post-frame buildings. Part I: Preventing frost heave. *Frame Building News* 22(1), 55–63.
- Freeman, M. H., Crawford, D., Lebow, P., & Brient, J. A. 2005. Comparison of wood preservatives in posts in southern Mississippi: Results from a half-decade of testing. *Proceedings*, American Wood-Preservers' Association annual meeting, New Orleans, LA, May 15–17, 2005, vol. 101, 136–143. Birmingham, AL: American Wood-Preservers' Association.
- Lutenegger, A. J. 2013, January. Helical screw piles. *Frame Building News* 25(1), 50–55.
- Scheffer, T. C., & Morrell, J. J. 1997, May. Ability of polyethylene boots to protect the belowground portion of small stakes against decay. *Forest Products Journal*, 47(5), 42–44.