QUICK GUIDE
Foam Plastic Applications for Better Building

Foundation Insulation Fundamentals: Basements, Crawlspaces & Slabs with Foam Plastic Insulating Sheathing (FPIS)

01.25.24

IMPORTANT! READ ALL INSTRUCTIONS BEFORE BEGINNING INSTALLATION

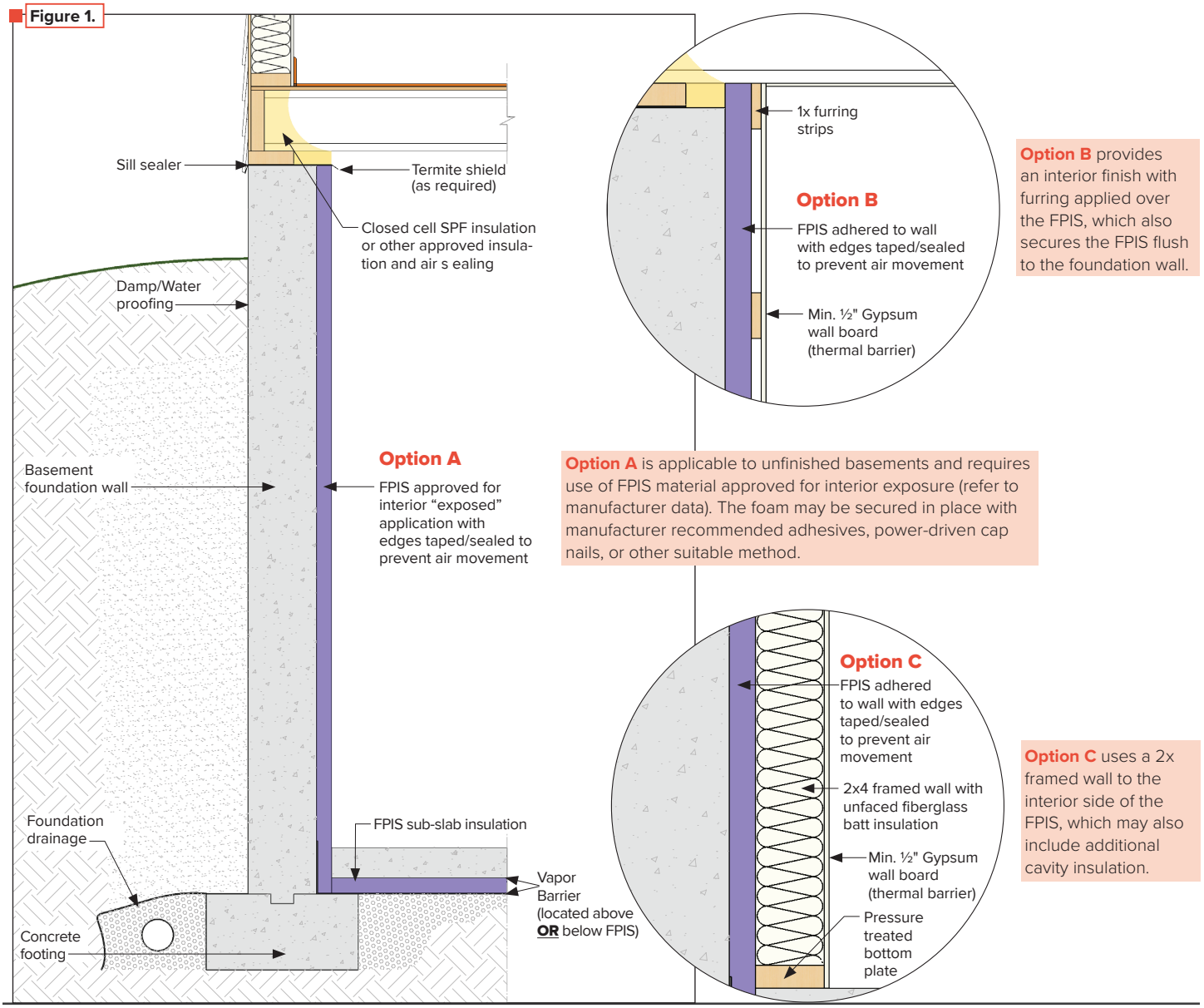
Insulating foundations can be completed in many ways. However, doing it right requires paying attention to a few key details to maximize the value of the foundation and its insulation. In addition to saving energy and increasing comfort, foundation insulation helps mitigate moisture problems and can even be used to raise the frost depth, saving thousands of dollars in foundation construction. This guide is intended to get you started by introducing some best practices for insulating foundations with foam plastic insulating sheathing (FPIS) properly installed as continuous insulation (ci). Resources are provided for further information and to support implementation.

Minimum insulation amounts will vary based on your locally adopted energy code and may be exceeded for improved performance. FPIS of ¾" to 2" in thickness is most common with R-values ranging from R4 to R12, depending on the type of FPIS material. For a high-performance home or commercial building foundation, and especially in cold climates, FPIS R-values of R-15 or more (~3" thick or greater) is not uncommon.

BASEMENT WALLS

Basement walls may be insulated on the exterior, interior, or both. However, the most common method for new and retrofit construction is to insulate on the interior side as shown in Figure 1. For basement retrofits, the basement wall insulation may be terminated at the slab surface.

Figure 1.



Option B provides an interior finish with furring applied over the FPIS, which also secures the FPIS flush to the foundation wall.

Option A is applicable to unfinished basements and requires use of FPIS material approved for interior exposure (refer to manufacturer data). The foam may be secured in place with manufacturer recommended adhesives, power-driven cap nails, or other suitable method.

Option C uses a 2x framed wall to the interior side of the FPIS, which may also include additional cavity insulation.

Some Key Points:

- In all of these details, no vapor retarder is applied to the interior side of the assembly because the FPIS serves as the thermal, vapor, and air control layers. This allows for drying to the interior as a best practice for foundation walls. Consult with a design professional as needed.
- FPIS joints should be taped for best performance.
- The sill and band joist should be air-sealed and insulated with closed-cell spray foam (as shown) or with equivalent methods.
- More detailed information and additional examples can be found in this Quick Guide on basement wall retrofits for use when remodeling or upgrading an existing basement to comfortable conditioned space.
- Finally, most foundation moisture problems are associated with poor exterior drainage. Proper surface drainage (slope away from foundation) and a foundation drainage system (per code) are keys to ensure the best outcome for below-grade spaces. Consult with a design professional as needed.

CONDITIONED CRAWLSPACE WALLS

Conditioned crawlspaces are just like conditioned basements, except they are not as deep and a slab-on-grade is not required (although a ground vapor barrier is always required). Conditioned crawlspaces are different from vented crawlspaces in that the entire floor system above does not require insulation. Instead, only the crawlspace walls are insulated and the space is conditioned (usually with a couple of HVAC supply registers). This approach simplifies construction, improves comfort of the floor above, and better controls moisture in the crawlspace and in the floor above. Because conditioned crawlspaces walls are no different than basement walls (other than they are typically unfinished), the same insulation details apply.

Figure 2 is similar to Figure 1, and Figure 3 shows a detail for exterior insulation with FPIS ci that is continuous with the above grade wall insulation. (This can allow for the band and sill to remain uninsulated on the interior side.) While a slab-on-grade inside the crawlspace is not required by code, the ground surface must still be treated with an aggregate layer (drainage and capillary break) as well as a ground vapor barrier (e.g., 6 mil poly) as required by code. It is important that the ground vapor barrier is secured and sealed to the foundation wall and all joints are taped. Finally, termite control and inspection measures may require consideration, particularly in areas subject to “very heavy” termite infestation probability.[1]

Figure 2.

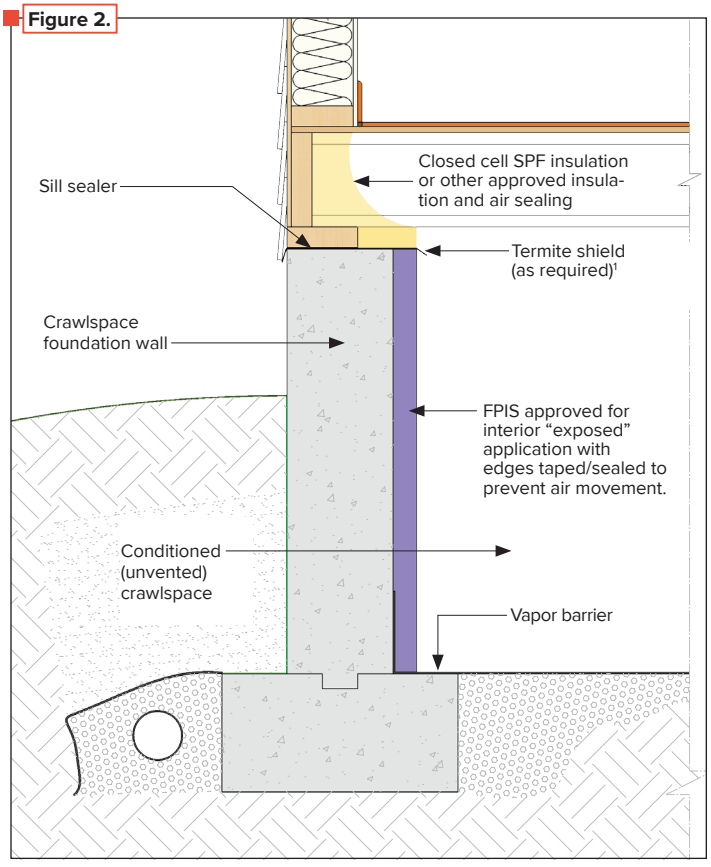
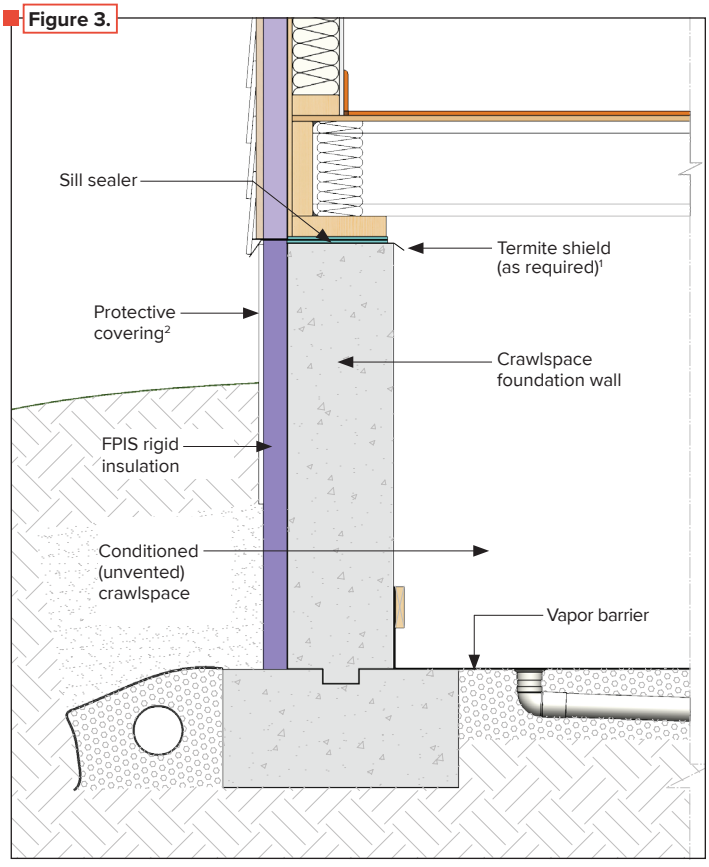


Figure 3.



[1] The foundation images provided in this document feature the use of a termite shield as a means to allow for visual inspection of termite shelter tubes. These should be combined with conventional use of termite soil treatment. Some localities or pest control operators may require alternate approaches like a termite inspection strip, a gap with no insulation, or removable insulation. For additional information refer to ABTG Research Report 1703-09, Protection of Wood-Frame Homes from Subterranean Termites: Evaluation of Building Code Provisions and Recommended Improvements.

[2] A protective covering is required to prevent physical and UV damage to exterior above grade foundation insulation. Typical protective coverings include fiber cement board, treated plywood, and metal or plastic composite panels.

SLAB-ON-GRADE

Slab-on-grade foundations generally come in two varieties: monolithic thickened edge slab (see Figure 4) and independent slab and stem wall (see Figure 5). A monolithic slab usually requires that the FPIS insulation be placed on the exterior edge. Such slabs are common in warm to mild climates where frost depths are shallow, unless the insulation is also detailed to protect the foundation from frost heave (see next section). An independent slab and stem wall foundation gives flexibility to insulate the slab only or the stem wall only (on its interior, exterior, or both sides).

The most significant detailing concern is to ensure that the vertical insulation is continuous, and there is not a thermal bridge pathway through the slab edge and stem wall to the exterior. Such thermal bridges (see Figure 6) significantly increase heat loss, discomfort, and slab condensation. While often overlooked, this detailing is required by code-prescribed slab insulation requirements. Consult a design professional for detailing options to avoid or minimize thermal bridging as needed.

Figure 4.

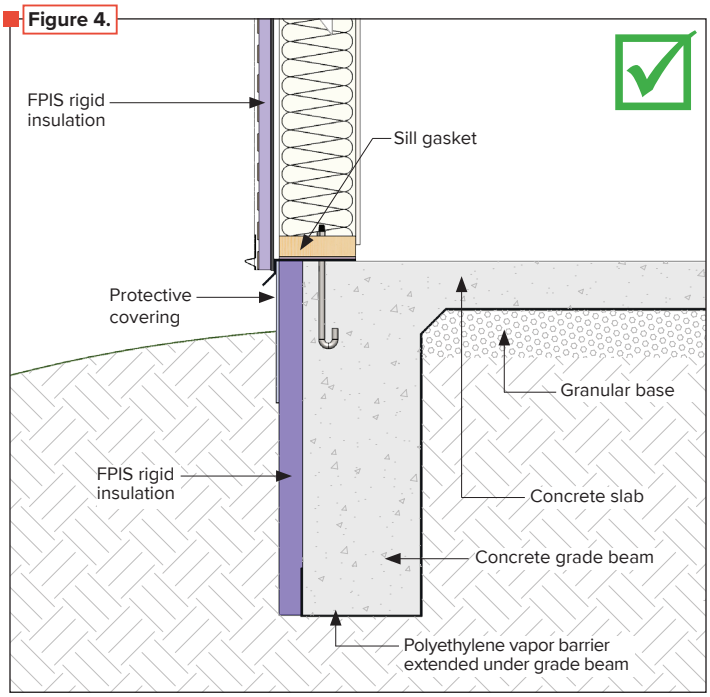


Figure 5.

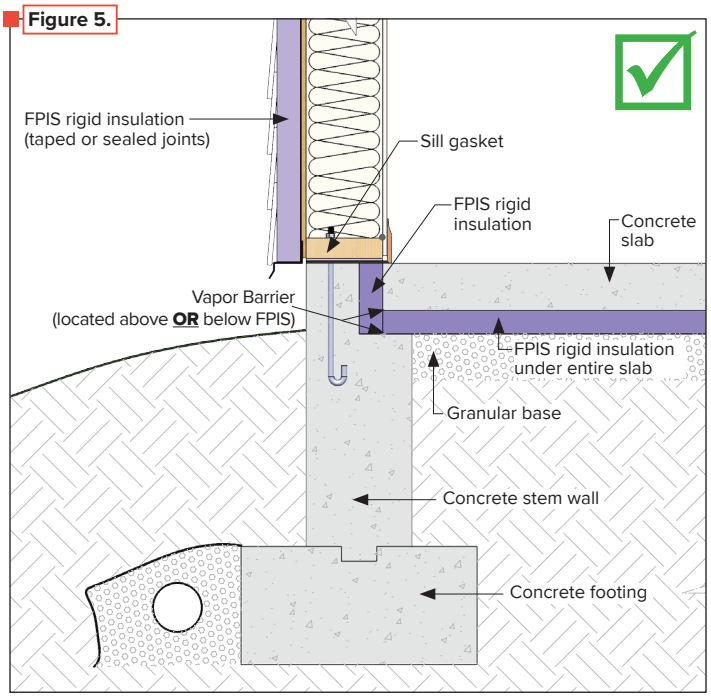


Figure 6.

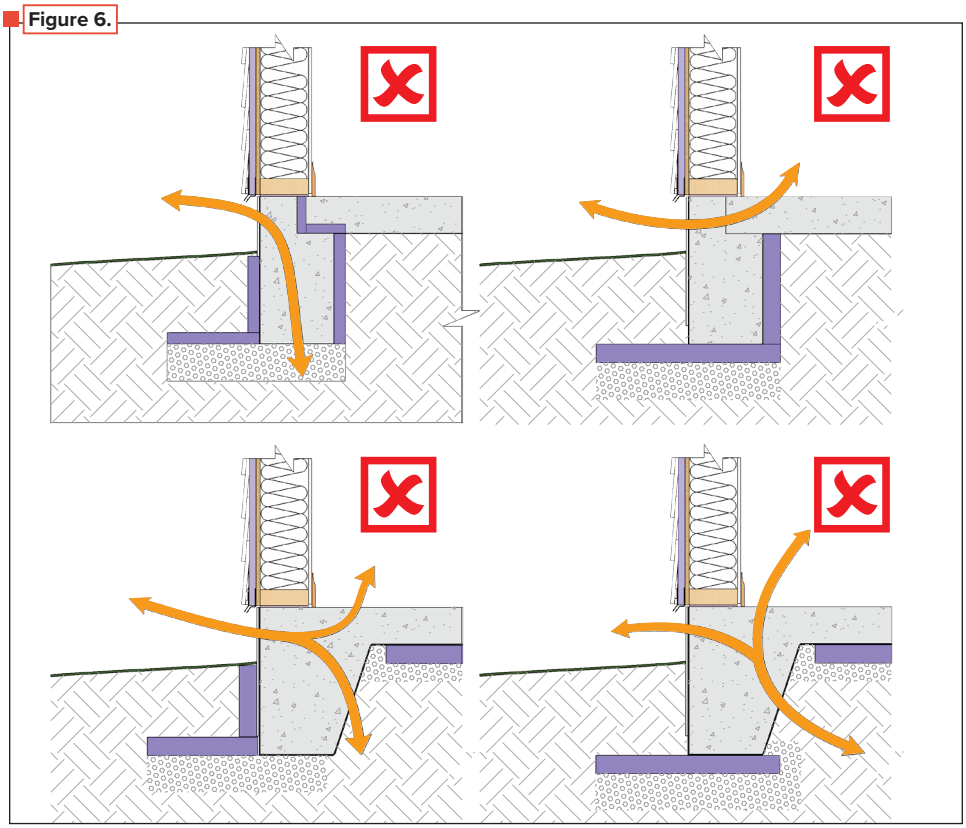


Illustration of common thermal bridges to avoid for conventional and FPSF foundations as applicable.

FROST-PROTECTED SHALLOW FOUNDATIONS

Frost-protected shallow foundations (FPSF) have been used on millions of commercial and residential buildings in Europe and the U.S. for decades and have consistently saved thousands of dollars in construction cost in areas where ground frost depths are more than a couple feet deep. The FPSF approach has been a recognized foundation construction method in U.S. model building codes since 1995. The strategically placed foundation insulation serves double-duty: increasing energy efficiency and effectively raising the frost depth by keeping the ground warm as though the footings are located in a warm climate.

Even in the coldest climates of the U.S. where frost depths exceed six feet, the FPSF footing depth can be as shallow as 16 inches, just like a "Florida slab." The FPSF method does not, however, apply to permafrost regions. Also, the insulation R-value requirements must satisfy both the local energy code and FPSF requirements that vary by coldness of climate based on a 100-year air-freezing index map (also see Additional Resources).

The basic insulation approach for three types of FPSF foundations are shown in Figures 7-9. They are only slight modifications of those shown in the previous sections for conditioned crawlspaces and slabs-on-grade. For example, the "wing" insulation shown in the figures is not required in climates that are moderately cold with moderate frost depths (unless needed to comply with the energy code's vertical/horizontal insulation dimension). Also, Figure 8 shows a permanent wood foundation stem wall, which is a code-recognized method, but the same insulation detail can be applied to more common masonry or concrete stem walls.

Figure 7.

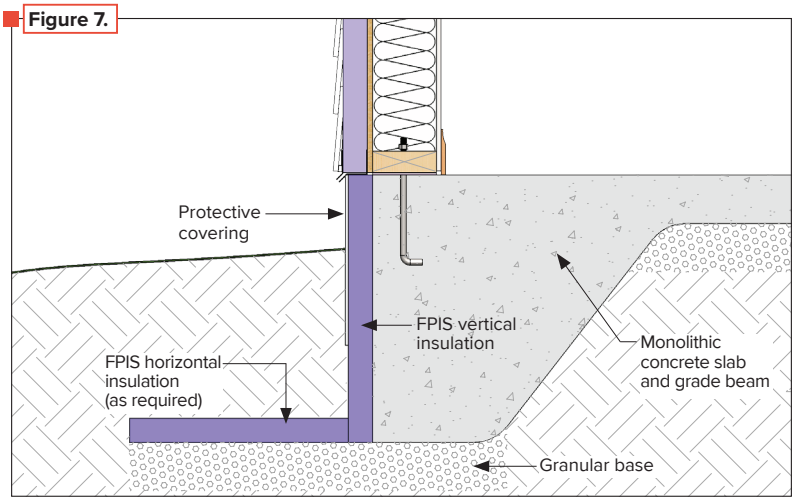


Figure 8.

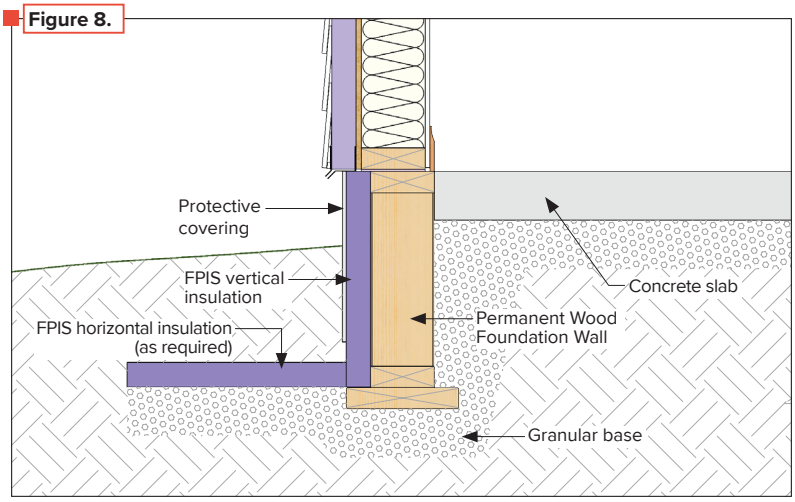
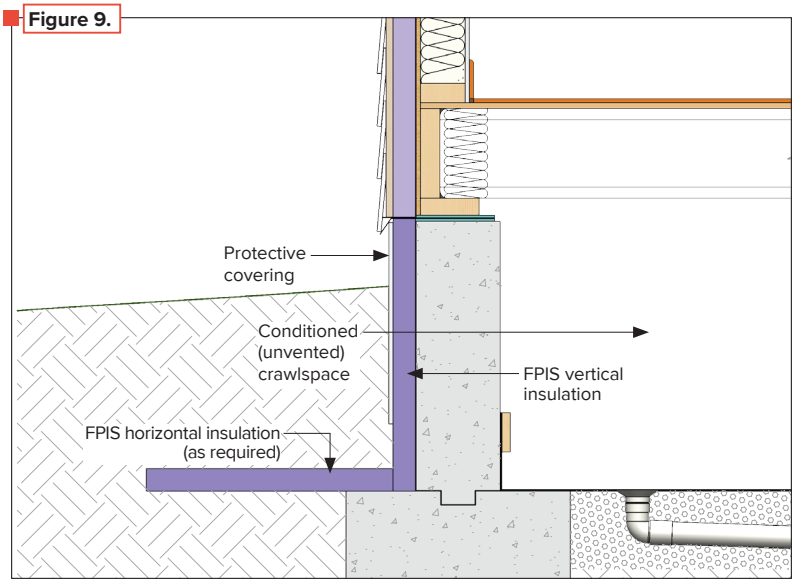


Figure 9.



ADDITIONAL RESOURCES

This Quick Guide provides a primer for effective foundation insulation practices. The following resources can help you bring them into reality with proper specifications meeting code requirements:

- 2021 International Energy Conservation Code (Residential), R-value Requirements
- ORNL Foundation Handbook
- ASCE 32 – Standard for FPSF
- Builder's Guide to Frost-Protected Shallow Foundations (FPSF)
- DOE Building America Solutions – Slab Edge Insulation