Lesser-Known Code Provisions That Can Have A Big Impact on the Performance of Building Enclosures

By Paul Grahovac, Esq., LEED AP

Photo by Daniel McCullough on Unsplash

Building enclosure consultants are always seeking design and construction practices that improve the performance of building enclosures. In my practice, I have found that a few lesser-known code provisions can be of great benefit to the building enclosure. These code provisions are related to fluid-applied flashing in rough openings, window installation sealant joints on the interior, and thoroughly insulated slab-on-ground footings. In addition to familiarizing yourself with the code provisions, being a member of the International Code Council (ICC) has its benefits as well. When code questions come up, being a member of the ICC entitles you to prompt support and clarification of code language.

FLUID-APPLIED FLASHING

Use of fluid-applied flashing in rough openings is not a new technology. The American Architectural Manufacturers Association (AAMA) first issued their "Voluntary Specification for Liquid Applied Flashing Used to Create a Water-Resistive Seal around Exterior Wall Openings in Buildings" in 2011 (AAMA 714). IIBEC members were introduced to the topic in the April 2013 issue of *Interface*, which previewed the widespread commercialization of fluid-applied flashing in the article, "Genesis of a Waterproof Flashing System for a Damp Climate." By the February 2015 issue of *Interface*, the authors documented that "Fluid-applied 'paint-on flashing' chemistries have matured and are here to stay" in the article, "Liquid-Applied Membranes."

In the code, fluid-applied flashing was first recognized (and reference was made to AAMA 714) in the 2015 *International Residential Code* (IRC Section R703.4). For commercial buildings, the ICC followed suit in the 2018 *International Building Code* (IBC Section 1404.4).

Although the most frequently specified system for meeting the air-barrier code requirements is mechanically fastened commercial building wrap, the U.S. Department of Energy refers to it as shown in **Figure 1** concerning air-barrier performance.

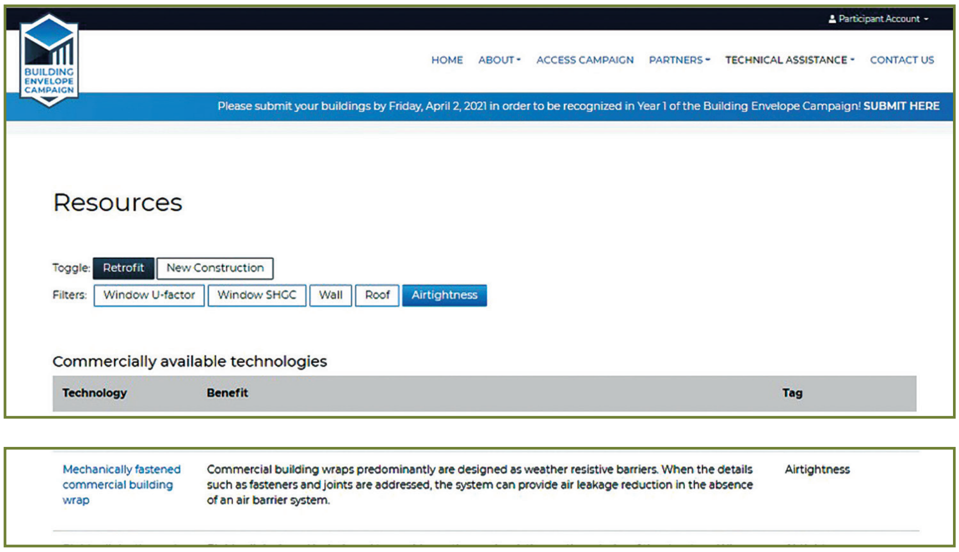


Figure 1. Characterization of mechanically fastened commercial building wrap on the U.S. Department of Energy website.

Typically, mechanically fastened commercial building wrap projects do not use the blower-door test option for code compliance of air-barrier requirements. However, fluid-applied rough-opening flashing has developed a reputation for facilitating successful airtightness objectives and passing the blower-door test option for code compliance of air-leakage requirements (**Fig. 2**). For code compliance, the air leakage during testing must be less than the maximum leakage rate.

Accidental Passive House Performance

"If you don't want Passive House performance, bring a drill to the blower-door test."
Paul Grahovac, LEED AP
Manager, Codes, Standards & Field Support
R-Guard Air & Water Barrier Systems
Building Envelope Group
PROSOCO, Inc.

- ICC-ES Code reports: ESR 3416, 4191, 4363
- FastFlash
- AirDam
- Cat 5
- Spray Wrap MVP

- Sehome High School
- Bellingham, Washington
- 263,888sqft floor area
- Maximum code leakage rate per specifications: 0.4 CFM/sqft @ 75 Pascals
- Passive House Institute (US) max leakage rate: 0.08 CFM/sqft @ 75 Pascals
- Test result: 0.095 CFM/sqft @ 75 Pascals
- Leak chasing to increase airtightness: None.
- Passive House Institute (Int'l) max leakage rate: 0.6 Air Changes per Hour @ 50 Pascals (ACH50)
- Test result: 0.39 ACH50

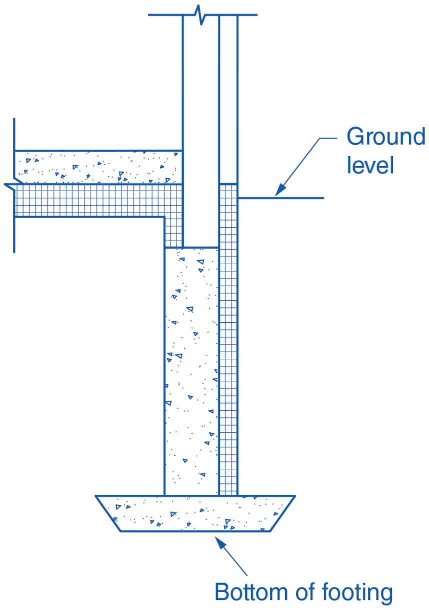
Figure 2. Passive House performance values and criteria for Sehome High School.

INTERIOR AIR AND WATER SEAL FOR WINDOW INSTALLATION

AAMA first published instructions for sealing the back or interior portion of the window frame to the prepared rough opening in 2008. In manufacturers' instructions, this approach was first shown in commercial product instructions in 2010. The objective of this detailing was to ensure that if a window leaks water into a rough opening (some would say *when* rather than *if*), the water cannot go into the wall assembly or into the building. Instead, it flows onto the treated rough opening and out onto the water-resistive drainage plane of the sheathing or CMU wall.

The recently issued 2021 IRC requires the use of such an interior seal in Section R703.4.1: "Air sealing shall be installed around all window and door openings on the interior side of the rough opening gap." If interior sealing follows the same acceptance path as fluid-applied flashing (first appearing in AAMA and then the IRC), it may be that the interior sealing requirement will next appear in the 2024 IBC. If building enclosure consultants want to specify interior sealing on an IBC project in the interim, the ICC has issued a code opinion confirming that a code official may use provisions of a related code to apply a code lacking anything specific on an issue. So, a basis exists for code officials to approve the interior seals on current commercial projects.

Exterior sealant joints are not prohibited and may be used in conjunction with the interior sealant joint. Some use exterior sealant joints due to historic practice, to eliminate insect habitat, to provide still-air insulation, or for aesthetic purposes. In this context, the external joint is sometimes referred to as "belt-and-suspenders" or a "beauty bead."



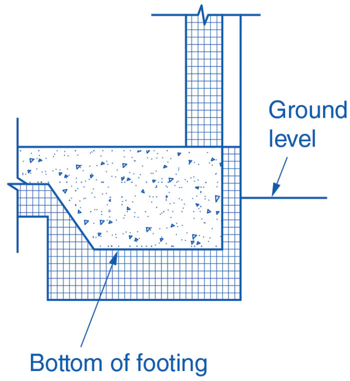
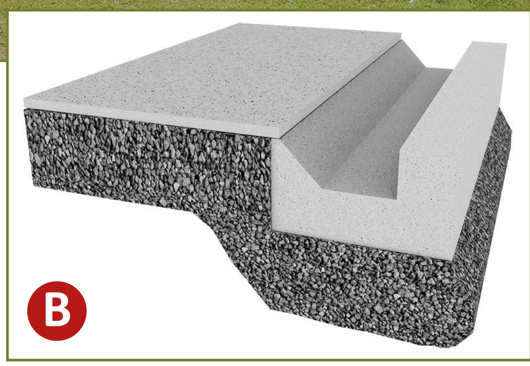


Figure 3. An example of conventional construction of slab-on-grade footings (left) and a frost-protected shallow foundation (right).

FROST-PROTECTED SHALLOW FOUNDATION

Figure 3 shows an example of conventional construction of slab-on-grade footings. In this construction, the vertical concrete footing connects to the horizontal concrete slab. The bottom of the footing must be below the frost line to avoid frost heave, which may damage the footing and the slab. In Chicago, for example, the footing must be at least 4-ft deep. This requires excavating a deep trench, laboriously positioning concrete reinforcing steel, and filling the trench with a significant amount of concrete.



Figures 4A and 4B. These figures show insulation forms used for frost-protected shallow foundation projects.

ASCE 32, *DESIGN AND CONSTRUCTION OF FROST-PROTECTED SHALLOW FOUNDATIONS*, ANALYSIS

What follows are sequential quotations from the standard. They provide a summary of its provisions. In some instances, comments are added in [brackets].

1. "Frost-Protected Shallow Foundation (FPSF): Foundations protected from frost heave by insulating in accordance with these provisions. Insulation is provided to retard frost penetration below the foundation and to retard heat flow from beneath the foundation, allowing shallower footing depths to be possible with no added risk of frost damage. Use of non-frost-susceptible soils is also included in certain applications." [Page 2.]
2. "Insulation placed below the floor slab shall not exceed a nominal R-value of 10 (hr • ft^2 • °F/Btu) (1.76 m^2 • °K/W)." [Page 5. For a multifamily project in Erie, PA, 4 in. of EPS was used. At 4.17 per inch, this would be over R-10. However, the R-10 threshold applies only to the ASCE 32 *simplified* calculation on Page 5. If the standard calculation is used, the limit is R-28. See Pages 6 and 7 discussed in item 3.]
3. "Where the R-value of the entire slab exceeds 28, follow the design procedure for unheated buildings." [This is when using the standard non-simplified design method for heated buildings. See Pages 6 and 7.]
4. "For climates where F100 is less than 2250°F-days (30,000°C-hr), wing insulation along the footing is not required...." [Page 7. See also Page 17, which provides F100 data for a sampling of various cities across the U.S. "TABLE A3. Estimates of the Mean Annual Temperature (MAT) and the Design Air-Freezing Index (F100) at Select Locations." A complete table of U.S. counties and their corresponding Design Air-Freezing Index (F100) is in the 2021 IRC Table R403.3(2).]
5. [**Figure 5** is located on ASCE 32 Page 10. There it is difficult both to read and understand. The markup below clarifies that the J-Form system may be used with the addition of non-frost-susceptible soil above or below the slab insulation.]

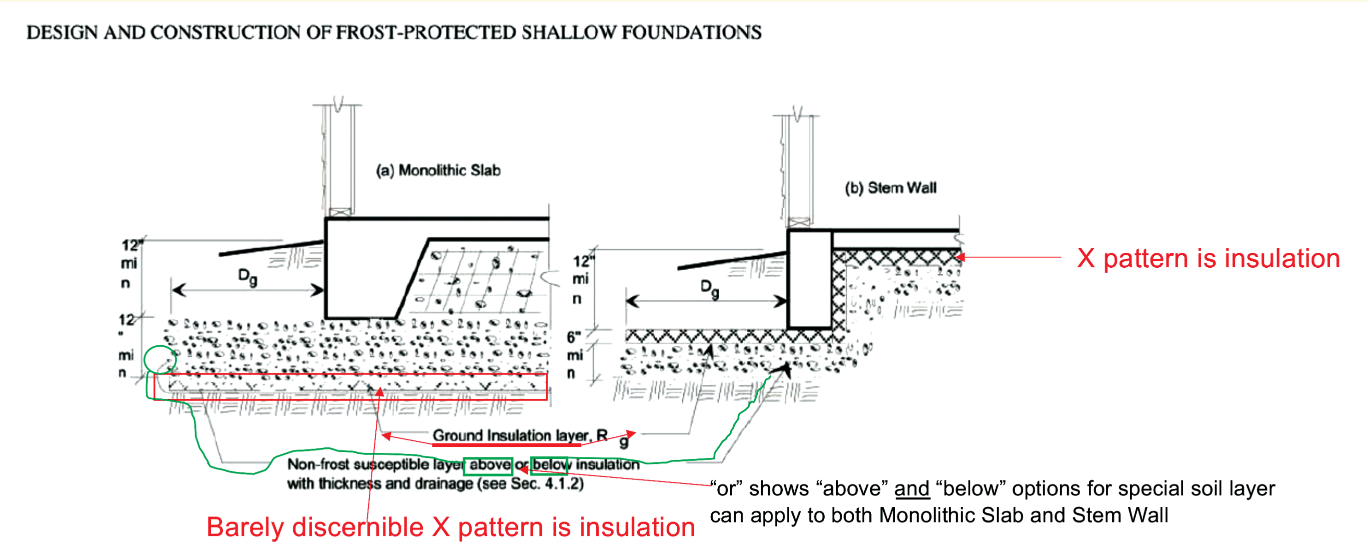


Figure 5. Slab-on-grade foundation for unheated buildings.

"COMMENTARY" [Commentaries are available for the building codes, and they can provide clarity for ambiguous provisions. The ASCE 32 commentary has some useful information. For complete commentary, see pages 25-28.]

1. "Much of this introduction to the commentary is devoted to some fundamental background related to frost penetration, foundation design, and frost-protected shallow foundations (FPSF). The remainder of the commentary gives additional background information, data, references, and explanations in accordance with the content and organization of the Standard." [Introduction.]
2. "The FPSF also works on unheated buildings or unheated parts of a building by use of a mat of insulation to conserve geothermal heat supplied to and stored below ground. Figure C3 illustrates the heat exchange process in an FPSF, which results in a reduced frost depth around the building. The insulation around the foundation perimeter conserves and redirects heat loss through the slab toward the soil below the foundation. Geothermal heat from the underlying ground also helps raise the ground temperature underneath the building and the frost depth around the building." [Page 26.]
3. "Historically, foundations have been protected from frost by their extension below a locally prescribed design frost depth or by erecting them upon solid rock." [Page 27. ASCE 32 does not define "foundation." At times, it appears to refer to the combined footing and slab in "slab-on-ground" as the foundation, which is contrary to common terminology. This clarifies that the footing is the foundation.]

Figure 3 also shows an example of a frost-protected shallow foundation. Note that the footing is hardly more than a thickening of the slab perimeter. The footing was created by placing the concrete into a form constructed of rigid foam insulation, which remains in place. The excavation required is measured in inches rather than feet. Much less steel, concrete, and labor are required with the frost-protected shallow foundation.

The building codes have provided for use of frost-protected insulated foundations since 1995. Amazingly, almost no one in the design and construction industry is aware of the concept, including code officials.

Maximum energy-efficient Passive House construction requires all footings and slabs to be completely insulated. Trying to insulate in a deep trench is very difficult, so the frost-protected shallow foundation approach is used. As a result of the growing popularity of Passive House construction, there is a growing awareness and acceptance of frost-protected shallow foundations for non-Passive House projects.

Figure 4 is a photo of an insulation form marketed for Passive House and all other frost-protected shallow foundation projects. The manufacturer refers to this as a J-Form because of its shape. There are also other similar systems on the market.

One means of satisfying the code requirements for frost-protected shallow foundations, and the one that has been in the code the longest, is to comply with Standard 32 of the American Society of Civil Engineers' *Design and Construction of Frost-Protected Shallow Foundations* (ASCE 32).

The J-Form system satisfies the heated buildings requirements of ASCE 32 without a horizontal perimeter wing outboard of the slab-on-ground foundation footings except in the Far North of the United States (such as Minneapolis, Minnesota), where such a wing is required. For vacation homes that may periodically not be heated, ASCE 32 requires that a layer of non-frost-susceptible soil be used over or under slab insulation that extends out from the footing similarly to wings needed for heated buildings in northern climates. The J-Forms and underslab insulation with wings satisfy both unheated and heated building requirements. Thicknesses for the J-Forms and the underslab insulation boards are determined by Engineers of Record based on the calculations set out in ASCE 32.

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Paul Grahovac holds degrees in economics and law. He has been active in the construction industry for 30 years—first as a construction defects trial lawyer and later as corporate counsel and an expert in air-barrier technology and panelized wall and window assemblies. He has practiced medical malpractice and hospital negligence law, and he also spent four years as an environmental lawyer and six years in technology development and licensing at a U.S. Department of Energy Radioactive Waste and Research and Development Laboratory. He is active in ASHRAE and well known in the Passive House community. He is employed at two related companies, PROSOCO and Build SMART, where his responsibilities include codes and standards. Build SMART prefabricates Passive House-certified wall and window assemblies and concrete insulation forms. PROSOCO is a provider of fluid-applied air sealing products.