

Technical Memorandum

DATE: 1/7/16
TO: Lance Boyce, Owner, Mono Slab EZ Form LLC
FROM: Ray McDougal, P.E.
SUBJECT: Code Compliance Analysis
MEMO:



The purpose of this analysis is to determine whether the product of concern complies with the wording and intent of the International Residential Code (IRC).

1.0 Applicable Code

While there are other codes in use by some jurisdictions, most of the U.S. uses the IRC. Some jurisdictions are using the IRC but have not adopted the latest version (2015). This analysis uses that 2015 version which is equal-to or more stringent than previous versions. Frost-protected shallow foundations have been in use for many years and the IRC has addressed this method of construction for several publications. Section R403.3 outlines the requirements.

2.0 Summary of Code

The code allows for the frost-protected shallow foundations with varying degrees of depth and insulation requirements depending on the climate at the construction site. The IRC provides a map and tables that assign an Air Freezing Index expressed in °F-days. Higher numbers represent more severe cold climates, 4000 being the highest. The IRC provides a diagram of the foundation section and a plan view showing the horizontal insulation. It also provides a table to show the depth and width of the insulation associated with the appropriate Air Freezing Index. These diagrams and table are shown below in Figures 2-1 and 2-2 and Table 2-1.

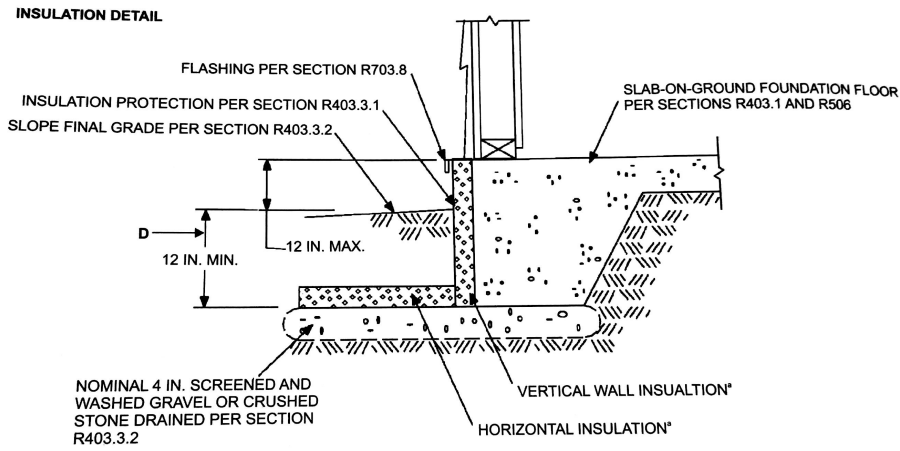


Figure 2.1 Insulation Section Detail from IRC Figure 403.3(1)

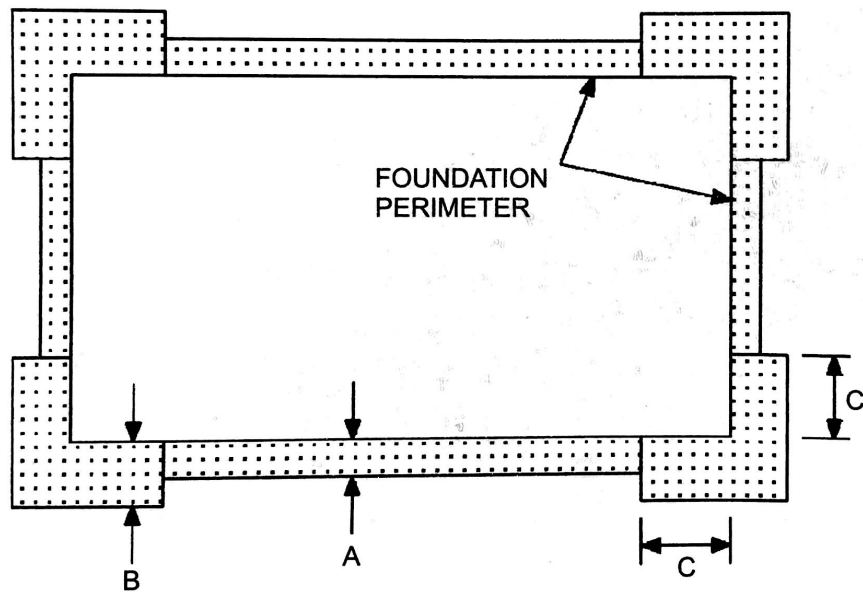


Figure 2.2 Horizontal Insulation Plan View from IRC Figure 403.3(1)

Table 2-1 Footing Depth and Insulation Requirements from IRC Table R403.3(1)

TABLE R403.3(1)
MINIMUM FOOTING DEPTH AND INSULATION REQUIREMENTS FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS^a

AIR FREEZING INDEX (°F-days) ^b	MINIMUM FOOTING DEPTH, D (inches)	VERTICAL INSULATION R-VALUE ^{c,d}	HORIZONTAL INSULATION R-VALUE ^{e,o}		HORIZONTAL INSULATION DIMENSIONS PER FIGURE R403.3(1) (inches)		
			Along walls	At corners	A	B	C
1,500 or less	12	4.5	Not required	Not required	Not required	Not required	Not required
2,000	14	5.6	Not required	Not required	Not required	Not required	Not required
2,500	16	6.7	1.7	4.9	12	24	40
3,000	16	7.8	6.5	8.6	12	24	40
3,500	16	9.0	8.0	11.2	24	30	60
4,000	16	10.1	10.5	13.1	24	36	60

For SI: 1 inch = 25.4 mm, °C = [(°F) - 32]/1.8.

- a. Insulation requirements are for protection against frost damage in heated buildings. Greater values may be required to meet energy conservation standards.
- b. See Figure R403.3(2) or Table R403.3(2) for Air Freezing Index values.
- c. Insulation materials shall provide the stated minimum *R*-values under long-term exposure to moist, below-ground conditions in freezing climates. The following *R*-values shall be used to determine insulation thicknesses required for this application: Type II expanded polystyrene-2.4*R* per inch; Type IV extruded polystyrene-4.5*R* per inch; Type VI extruded polystyrene-4.5*R* per inch; Type IX expanded polystyrene-3.2*R* per inch; Type X extruded polystyrene-4.5*R* per inch.
- d. Vertical insulation shall be expanded polystyrene insulation or extruded polystyrene insulation.
- e. Horizontal insulation shall be expanded polystyrene insulation or extruded polystyrene insulation.

3.0 Code Compliance

A section view of the Mono Slab EZ Form is shown in Figure 2.3 below.

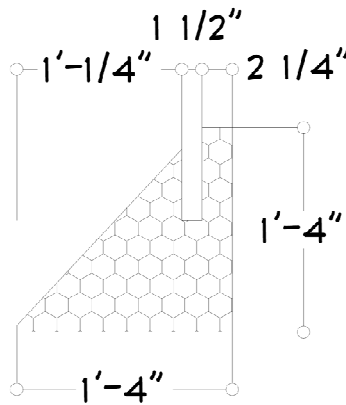


Figure 2.3 Mono Slab EZ Form Section View

3.1 Insulation R-Value

As shown in Table 2-1, the required *R*-value for vertical insulation ranges from 4.5 to 10.1. The Mono Slab EZ Form is made of Type I Expanded Poly Styrene (EPS). The IRC footnotes shown in Table 2-1 specify an *R*-value of 2.4 per inch for Type II EPS and an *R*-value of 3.2 for Type IX EPS. These values are significantly lower than the specifications provided by the manufacture according to their ASTM C578 testing. A summary of their specifications is provided in Appendix A. We did not use the manufacture test results for *R*-value code compliance, however, the data is helpful to see the relationship of foam density and *R*-value performance. Figure 2.4 shows this relationship in a graphical format.

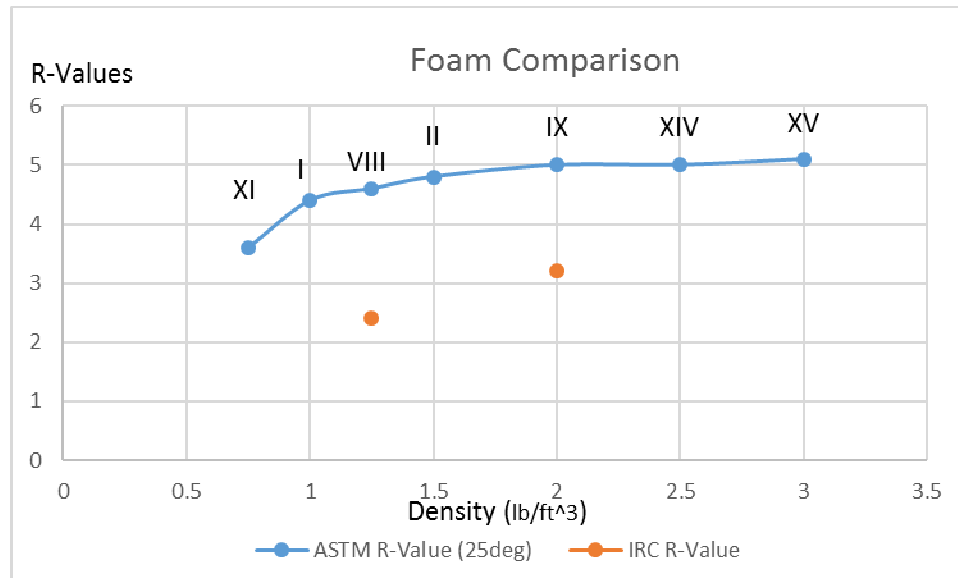


Figure 2-4 EPS Comparison

The foam types in the graph above are listed in order of density. The relationship of R-Value to Density is close to linear for foam types I through XV. If we extrapolate the IRC values, then the R-value for type I foam would be R-1.6 per inch.

As shown in Figure 2.3, the EZ form at the top has a channel for a 2x lumber stiffener. The product is shipped with an eps insert that can be placed in this channel once the lumber is removed. With the insert in place, the width of the insulation is 3.75 in. For Type I foam, the calculated R-value is R-6.0 at the top and increases to R-25.6 at the bottom. If type II foam is used the values are R-9 top and R-38.4 bottom. If type IX is used, the values are R-12 top and R-51.2 bottom. This product differs from the products for which the code was written because the profile is shaped in a triangle and increases in thickness with depth. Governing officials may treat this product with more leniency because of the much greater R-values throughout the majority of the section.

3.2 Horizontal Insulation

As shown in Figure 2.2 and Table 2-1, the horizontal insulation requirements range from “Not Required” to 24”. The EZ Form is 16” wide so it meets the horizontal insulation requirements for all zones up to 3000 °F-days. To meet the exact letter of the code, the form would need an insulation extension of 8” for zones greater than 3000 °F-days. Since the R-value of the form at the bottom is so much greater than required, the governing official or inspector may conclude that the extensions are not required.

In Figure 2.2, extensions are also shown in the corners. These are required in zones 2500 through 4000 and are either 30” or 60”. The extensions would need to have equal-to or greater-than the R-value of the EZ form.



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4.0 Interior Form Viability

The EZ Form construction method utilizes a triangle section of EPS in the interior of the structure to form the inside of the integrated footing. This EPS section remains in place under the finished slab. The minimum density of EPS used for EZ Form is Type II EPS (0.9_lbf/ft³ min) which has a compressive strength of 10_psi. The dead load for a 4" concrete slab is 49_psf or 0.34_psi. Typical live loading ranges from 35-100_psf. 100_psf = 0.7_psi. So for a 4" slab and a 100_psf live load, the combined loading is only 1.0_psi.

5.0 Conclusions

The EZ Form product complies with the 2015 IRC for use in frost-protected shallow foundations. In some cases, type II or type IX may be required. Also, horizontal insulation extensions may be required at the inspectors' discretion. The product can be used to produce a structurally sound foundation provided the footing size and reinforcement is appropriate for the loading. For most residential applications, the footing sizes in IRC Table R403.1 will be applicable but large homes or homes in areas of high snow loading should have footings sized by an engineer.