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ICF Wall Construction

ICF Wall Construction Details (*Wall 7*)[1]

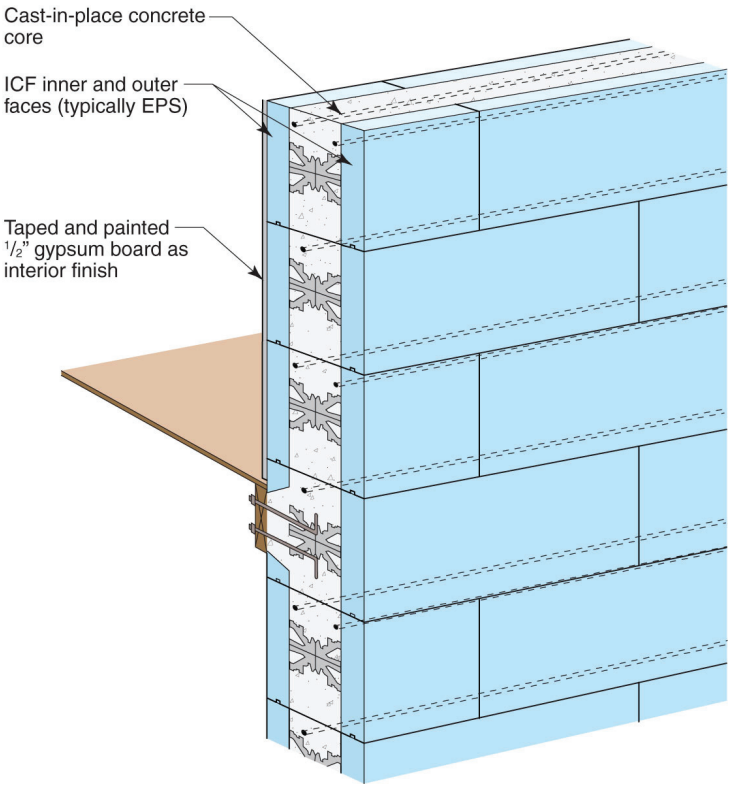
- ICF inner and outer faces; typically EPS, and less commonly cement wood fiber
- Cast-in-place concrete core

Scoring: How It Rates

The scoring of each wall system is based on the following five categories. A score of 1 is the lowest score in each category and represents the worst possible technology for each category or highest possible relative cost. A score of 5 is the highest score available in each category, and is representative of the best available technology available on the market or lowest relative cost.

Thermal Control	4
Durability	5
Buildability	4
Cost	2
Material Use	3
Total	**18**

ICF construction is a very durable construction strategy provided the rainwater management details are constructed correctly. Generally, ICF construction alone cannot achieve a high R-value in cold climates, but some high-R-ICFs (≥R-40) are starting to appear on the market.



Introduction

This overview summarizes ICF wall construction including the advantages and disadvantages of this construction strategy. A more detailed analysis and direct comparison to several other walls can be found online.[1] The scoring system is subjective based on the relative performance and specifications between different wall systems. Complex two dimensional heat flow analysis and one dimensional hygrothermal modeling were used to determine moisture related durability risks for analysis.

For a more complete analysis of this and other wall constructions, go to www.buildingscience.com.

Thermal Control

Installed Insulation R-value: R-values of Insulated Concrete Form construction vary considerably with the type, and thickness of form. The most common ICF form is constructed of EPS insulation in the range of $2^1/_2$" thick on the interior and exterior. Other ICF materials include cementitious wood based forms, some of which are constructed with an extra layer of insulation (e.g. Rockwool) in the form.

Whole-wall R-value: Using two dimensional heat flow analysis shows that there are few thermal bridges from the interior to the exterior on an ICF wall. A 9" foam ICF form with 5" of EPS has a whole-wall R-value of approximately R-20.

Air Leakage Control: The concrete core in ICF construction forms and air barrier in the field of the wall. Air leakage will occur at penetrations through the wall if they are not detailed correctly.[2]

Typical Insulation Products: EPS foam insulation forms and, less commonly, cementitious wood based forms.

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Durability

Rain Control: Rain leakage into the enclosure is the leading cause of premature building enclosure failure. Rain control is typically addressed using a shingle lapped and/or taped drainage plane such as building paper or a synthetic WRB (i.e. homewrap). Intersections, windows, doors and other penetrations must be drained and/or detailed to prevent the penetration of rainwater beyond the drainage plane.[3] There is little to no moisture buffering capacity of an ICF wall so even a minimal amount of water, undetectable in standard construction, will have durability issues in ICF construction.

Air Leakage Control: ICF construction strategies form air barriers in the field of the wall. All through wall penetrations require air sealing details.[4]

Vapor Control: There are no significant risks to moisture durability from vapor drive in ICF construction. Both the concrete core and foam skins provide sufficient vapor diffusion resistance to control condensation of vapor driven from either side.

Drying: ICFs will dry both to the interior and exterior depending on climate and time of year.

Built- in Moisture: Since ICFs are poured concrete walls in forms with relatively low vapor permeance surfaces, the concrete will dry very slowly, and should be allowed to dry to both sides following the completion of the wall system.

Durability Summary: There are very few risks associated with air leakage and vapor condensation of ICF construction. The most common durability issue is from rainwater leakage into the enclosure. ICF forms typically do not have any buffering capacity of leakage, so even a small leak, that may occur undetected with no durability risks in a wood framed wall, may affect the interior of and ICF building. The ICF wall itself is not susceptible to moisture related issues but interior finishes are generally sensitive to moisture.

Buildability

Generally, building with ICFs is quite easy and straightforward following initial training. Problems in the past have occurred with air pockets in the forms, as well as bulging and breaking of forms due to the hydrostatic pressure of concrete. These problems are well documented and there are strategies to address these issues.

Cost

The cost of ICF construction varies considerably depending on the type of forms chosen, geometry of construction and location. ICF construction is more expensive than standard construction.

Material Use

ICF walls use less concrete than an alternative wall built entirely with concrete, and concrete is very high in embodied energy. The wood framing can be minimized by attaching the drywall directly to the ICF block on the interior.

Total Score

ICF construction is a very durable construction strategy provided the rainwater management details are constructed correctly. Generally, ICF construction alone cannot achieve a high R-value and will require other insulation strategies in combination for cold climates, which is commonly done in practice. ICFs are ideal for basements and multi-story residential and are being adopted as the dominant choice in some markets..

References

1 Straube, J., & Smegal, J. (2009). *Building America Special Research Project - High-R Walls Case Study Analysis*. Retrieved from buildingscience.com.

2 Straube, J. (2009, 04 22). *BSD-014 Air Flow Control in Buildings.* Retrieved from buildingscience.com.

3 Lstiburek, J. W. (2006). *Water Management Guide.* Westford: Building Science Press Inc.

4 Lstiburek, J. (2008, 08 20). *BSD-104: Understanding Air Barriers*. Retrieved from buildingscience.com.