The Pennsylvania Housing Research Center

New and Improved Basement Wall System

Builder Brief BB0199

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Introduction

Over 85% of all new houses built in Pennsylvania have a basement. For many homeowners the basement represents the one area in the house with the most potential for future use. By investing some sweat equity in finishing or modifying the basement area, the occupants can, at relatively small cost, create storage, recreation and even sleeping space. Of course it helps if there is sufficient headroom, some natural light, good access and the basement is not damp, cold or smelly. The builder has a very important influence on whether the basement has any potential for cost-effective modification, finishing and use. These issues are addressed in some detail in PHRC Report No. 50 *Below-Grade Construction: Issues and Needs*.

Over the past 10 to 15 years there have been improvements to basement construction and several different basement systems have been introduced into Pennsylvania and the Mid-Atlantic States. The intent of this brief report is to identify and discuss these new or improved foundation wall systems for the benefit of builders and remodelers and their customers. This information is discussed in much more detail in the PHRC Report No. 51 *Foundation Wall Systems for Houses*.

Background

The foundation wall system of a house is required to perform numerous functions over the life of the building, usually at least 50 years. Some of these functions may be categorized as follows (see Fig. 1):

- **Support**: the weight of the building
  the lateral loads from the soil,
  wind, snow and other live loads
- **Control**: heat flow (energy efficiency),
  air and moisture,
  insects, animals, etc.

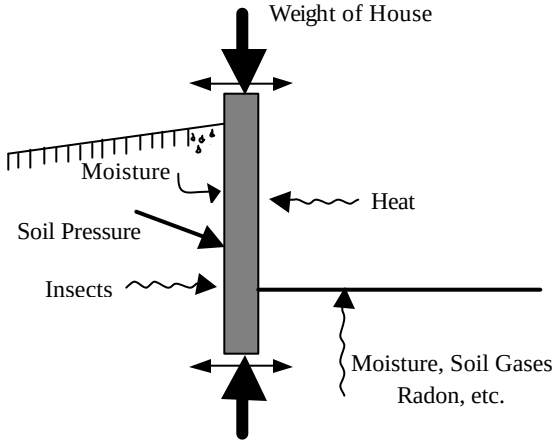


Figure 1. Foundation Wall System

The main reason most of Pennsylvania's new houses are built with a basement is because the footer must be below the frost line to avoid frost damage (between 2 and 4 feet). Additionally, the wall should extend a minimum of 6 inches above grade. The additional cost of excavating and constructing a full height basement wall can be justified in terms of providing storage space and the future potential for conversion to useable space.

The decision as to what basement wall system to choose is, a considered risk on the part of the builder. The benefits of using a different system may include reduced construction time, reduced cost, market appeal, and better value. However, if the system fails to perform any of the necessary functions it could be costly for the homeowner as well as the builder.

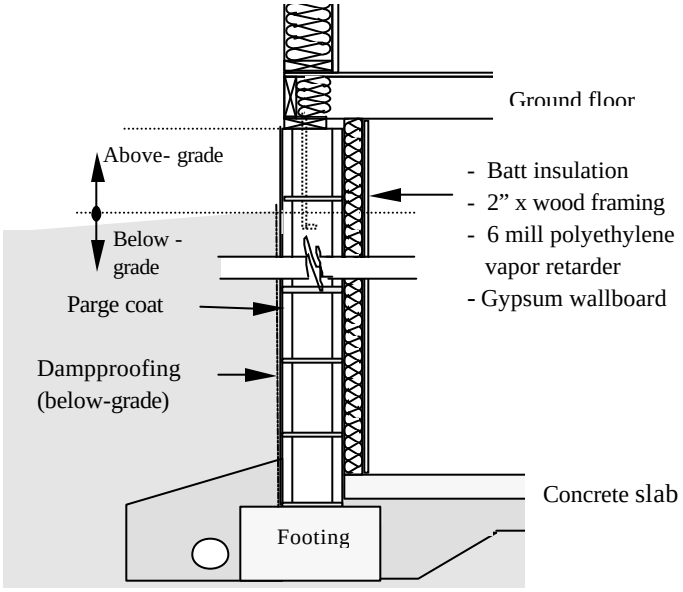
Builders need to give some thought to foundation wall systems because the expectations of homebuyers are changing. They expect something better than a cool, damp, musty space suitable for storage and locating the heating system and, perhaps, the washer and dryer. The basement should be, at least, a finishable, potentially habitable space. Since the below-grade area typically accounts for 33 to 50 percent of the total floor area in a house, it is important for the

builder to ensure that this area has the potential to be warm and dry and habitable.

Concrete Block or Cast-in-Place (CIP) Concrete Systems

Concrete block and cast-in-place (CIP) concrete foundations are the most common foundation wall systems used for single family housing in Pennsylvania. Which of these standard systems is preferred in a particular area depends upon the local cost of labor and materials, soil conditions, and the complexity or layout of a particular foundation.

Figure 2. CIP Concrete Wall System



These systems require a concrete strip footing on which the wall is constructed. The outside surface of block walls is typically covered with a parge coating (cement and sand) and both systems have to be damp proofed. Builders and their subs are familiar with the basic versions of both block and CIP foundation wall systems. The builder knows how much they will cost and how long they will take to construct.

However, the control of moisture and heat are concerns. Both wall systems are susceptible to wetting and moisture problems if not properly backfilled, or if exterior drainage is inadequate, or if the damp proofing is not properly installed or is inadequate. Neither block nor CIP concrete has much resistance to heat flow. Therefore in order to ensure better performance there must be better control of heat and moisture. It makes sense to simultaneously attempt to improve the overall quality of the below-grade space. Substantive improvements can be made by providing better drainage, upgrading the resistance to exterior moisture and insulating the wall. In theory placing the thermal insulation on the outside of the wall is advantageous. The exterior insulation improves drainage, allows the house to take advantage of the thermal mass of the wall and decreases the possibility of condensation on the interior of the wall. In practice interior insulation, largely because it is less prone to damage both during and after construction, may be preferable. If properly constructed these improved versions of block and CIP concrete wall systems (see figure 2) can provide finishable and habitable below-grade space.

Precast Concrete

Precast concrete foundation systems involve concrete elements that are manufactured off site under controlled conditions and then assembled on site. As far as we know, the only precast system readily available in Pennsylvania is the Superior Wall system shown in Figure 3.

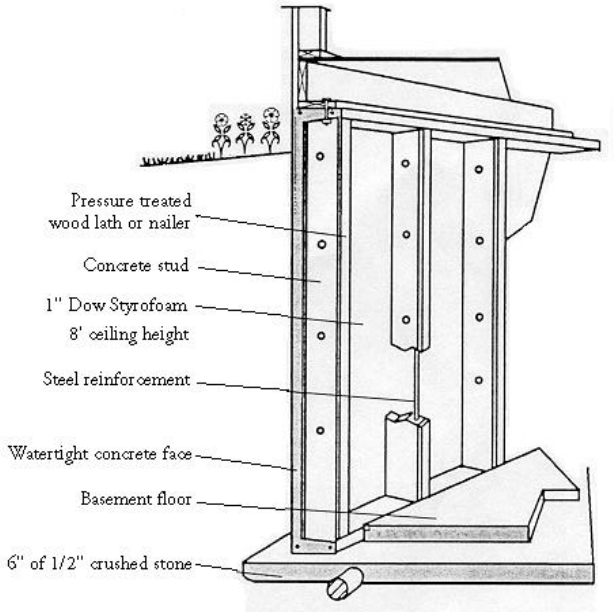


Figure 3. Superior Wall System

Walls are typically available in the following heights: 4' frost walls, 8'2" normal walls, 9' and 10' full-height walls. Wall elements are shipped in sections, set on a base of compacted crushed stone and then bolted, glued and sealed together. A strip footing is not required for this system. Erection requires a light crane and is usually completed in less than a day.

The wall system incorporates 1" of extruded polystyrene insulation that provides a system R-value of 7.5. The system is easily finished on the inside in the future. Batt insulation can be added and drywall may be attached to the vertical wood nailer provided at each of the concrete studs. Electrical wiring and small diameter pipe may be easily installed through prearranged holes in the studs.

The locations of windows, doors or other openings must be determined before casting. This system is not easily changed or modified after assembly. Proper sealing and caulking of joints is important to ensure a watertight system.

Insulated Concrete Forms

Insulated concrete forms (ICF) systems are similar to CIP concrete walls except that the formwork, which is comprised of foam insulation, is left in place after the concrete has cured. This system can be used for above and below grade walls. The approach has been used in the US since the 1970s but there has been a significant increase in use over the past 10 years. More than 47 ICF systems are currently available. A list of manufacturers is contained in the PHRC Report No.51.

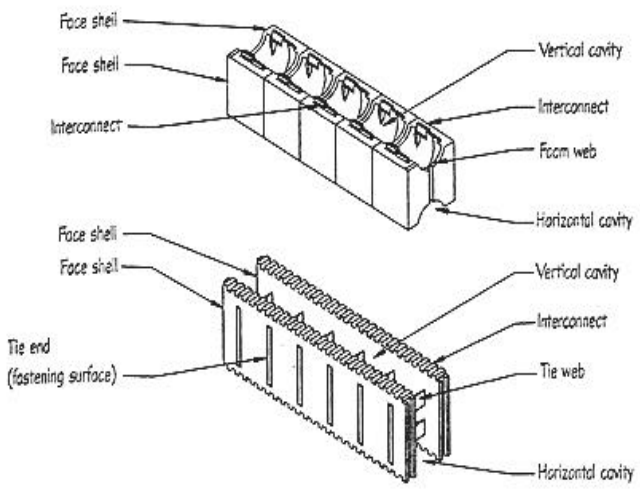


Figure 4. Insulated Concrete Forms

The insulated forms are typically lightweight modular blocks made from extruded or expanded polystyrene or urethane foam. The foam blocks are set on a standard, concrete strip footing. The lightweight foam blocks are designed to be quickly stacked together and then braced for lateral support. Most of the systems are designed to be assembled by individuals with average skills. Concrete (sometimes with a plastisizer additive) is then pumped into the forms. Most manufacturers require the below grade portions of the wall to be dampproofed with a material that is compatible with the foam formwork. The insulated forms retain the heat of hydration that is generated during the curing process and this permits construction in colder weather. Windows and doors are fairly easy details to accomplish with most of the systems. The ICFs provide a highly insulated wall, usually between R-18 and R-35.

There are two major differences between the various ICF systems. First is the nature of and the material used for the web that holds the two insulating layers together until the concrete has cured. Web materials include galvanized steel, plastic, wire and foam. Second is the methods used for fastening exterior or interior finishes. Most systems provide a method for attaching finishes with nails or screws. Glues and adhesives are not allowed to install interior or exterior finishes by some building codes.

To install utilities (electric, plumbing, communica-tions, etc.) the interior surface of the insulation can be grooved with a router and the wire or piping is laid in the groove or conduit can be placed within the form before the concrete is cast. Additionally the interior surface must be finished with fire-retardant wallboard to comply with building codes.

Unless preventative measures are taken, foam insulation in contact with the ground is susceptible to termites. The insulation does not provide a food source but it does provide a habitat and an undetectable means to enter the house. This might be a problem especially for systems with foam webs. Unless proper steps are taken to eliminate the termite threat, all foam based ICF's should be used with caution.

Durisol

The Durisol wall system that was developed over 50 years ago in Europe, has been used in Canada since 1953. It has recently been introduced into the U.S. market. The proprietary material "Durisol" is a composite wood/cement material that has several unique features: it is insulating, light weight, fire

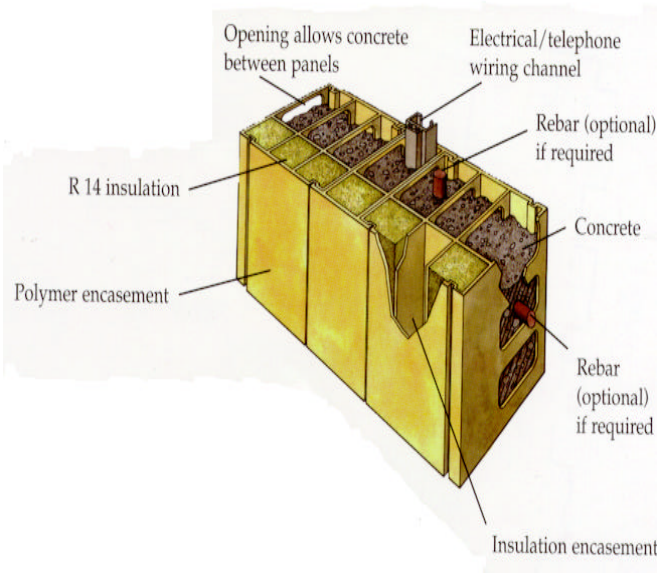
resistant, and completely resistant to rot, freeze-thaw, rodents, and termites. In addition, it is capillary inactive, self-draining, workable with standard carpenter tools, nailable, screwable, and highly sound-absorbent. Durisol is also ideal for the application of most interior or exterior finishes, especially cement-based stuccos.

Large blocks, about 1'x 3', similar to those used in the ICF systems, require only semi-skilled labor and many of the same procedures as those used when building with expanded polystyrene ICFs. The Durisol blocks are dry-stacked and reinforced as required and then filled with concrete. To enhance the thermal insulation and thermal mass contribution, a layer of inert mineral wool—not foam—is inserted in the exterior side of the blocks. The concrete and Durisol bond extremely well together, much better than with the very dissimilar foams used in most ICF systems. The insulated block has an R-value of about 8 to 23, depending on the thickness of the block (thermal mass of about 17 Btu/ft^2/°F) and the amount of insulation.

Encapsulated PVC System

The encapsulated system employs extruded rigid polymer components that slide into place and interconnect to create a concrete formwork that remains in place after the concrete is cured. The PVC formwork provides an interior finish of the wall that is virtually maintenance free. The system is constructed on top of a strip footing similar to a block or CIP wall.

Figure 5. Encapsulated PVC System



The multiple cells of the form allow the insulation to be placed on the exterior of the wall thereby taking advantage of the mass of the wall and keeping the interior wall surface temperature warmer. The warmer interior surface temperature provides several advantages including increased comfort and decreased chance of condensation and mold or mildew growth. And the system has been tested to show that it is termite resistant.

The system accepts the insulation of services (electrical, telephone, data, etc.) during the erection of the forms. This may require additional coordination issues by requiring subcontractors, and building inspectors, to be onsite more than one time. The inclusion of windows and doors must be installed at the time of casting. Future modification of the systems will have the same problems associated with the use of other concrete products.

This system is seeing widespread use in many countries, including the USA, but to date has not been used in Pennsylvania. The product is slowly making its entry into the USA and will likely be available in Pennsylvania in the very near future.

Builder Considerations

Making the decision to try a new basement wall system is not easy. Some of the things that a builder must consider includes the cost of materials and labor, training of crews, buyer acceptance, design flexibility, thermal performance, coordination of subcontractors, code approval, and water and insect resistance.

These issues and others are discussed in greater detail in three PHRC Reports: No. 51 *Foundation Wall Systems for Houses*; No. 50, *Below-grade Construction: Issues and Needs*; and No. 55, *Economic Assessment of Basement Insulation for*

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Pennsylvania. These reports are available from the PHRC for $25 to cover printing and shipping costs.