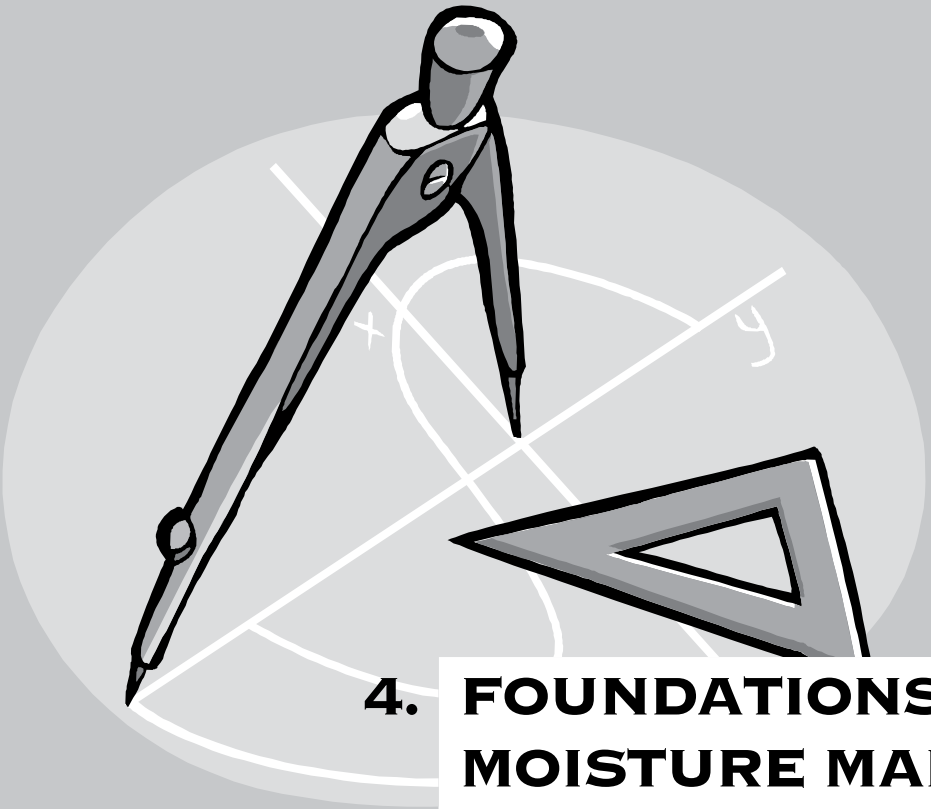

4. FOUNDATIONS AND MOISTURE MANAGEMENT

FOUNDATIONS AND MOISTURE MANAGEMENT

It can be argued that the most significant component of a building is the foundation. As a result, providing a quality foundation is often the most expensive consideration in constructing a new home.

Foundations are integral to helping the home withstand water, control dampness, reduce heat loss, and minimize unwanted air flow. Paying attention to details when constructing the foundation will help prevent damaging moisture buildup and make it easier to keep the floor dry.

MOISTURE MANAGEMENT

The following construction practices can help minimize water problems as well as curb environmental concerns:

- Use insulated shallow foundations in northern climates; consider pier and beam foundations instead of slabs on grade.
- Insulate foundation before backfill.
- Use a nonporous, low toxic sealant.
- Install enhanced foundation waterproofing.
- Use non-asphalt-based damp proofing.
- Reuse form boards.
- Use aluminum forms.
- Install proper vapor retardant under slab or in crawl space floor.
- Avoid using expansive soils and replace with a backfill material that does not expand when wet (for example, recycled aggregate in concrete).

PERIMETER FOOTING DRAIN

- Install perimeter or footing drain system of perforated pipe below the level of the basement slab on the inside and outside of foundation.
- Wrap pipe with filter fabric and surround with clean gravel or crushed stone.

DIRECT SURFACE WATER AWAY FROM HOUSE

To keep surface water from soaking in around the foundation, all roof runoff must be directed away from the house. This means putting effective gutters all around the building and sloping the final grade away from the foundation at least 5" in the first 10' (That's ½" per foot.) To protect the footing from subterranean water, it must bear on at least 4" of a nonfrost-susceptible material such as washed gravel or rock.

FRENCH DRAIN

A French drain is a drainage system that consists of a trench dug into the ground through and out of an area with poor drainage. The trench is filled with a porous material—usually gravel, crushed stone, or slag—along with a perforated PVC plastic pipe to collect and channel unwanted ground water. It is better to install the drain during construction, rather than later, to avoid problems digging around utilities, porches, and other obstacles. French drains will clog over time, so they need to be cleaned periodically.

The following options for foundation material are discussed in this chapter:

A. Poured Concrete

B. Preserved Wood

C. Insulated Concrete Forms (ICEs)

D. Insulated Concrete Forms

E. Frost Protected Shallow.

A. POURED CONCRETE

IMPLEMENTATION OF POURED CONCRETE

Selecting a poured concrete basement requires diverting surface water away from the house and limiting water seepage by installing a perimeter drain. This is especially important for all basement footings sloped to allow for daylighting, drywells, or sump pits.

- Carefully estimate the amount of concrete required to avoid waste.
- Use fly ash. Packaged in bulk or bags, fly ash cement is generally available in two standard colors; coloring agents can also be added at the job site. Fly ash can be used sparingly as an admixture or in large amounts to replace Portland cement. Casa Verde Builders in Austin, Texas, uses 40 percent content fly ash in all their concrete.
- Manufacturers are developing specialty cements, which should be widely available soon, that can be formulated to produce various set times, cold weather resistances, and strengths and strength gains, depending on the job.

FLY ASH is a fine, glass-like powder recovered from gases created by coal-fired electric power generation. U.S. power plants produce millions of tons of fly ash annually; this fly ash is sent to landfills.

Fly ash is an inexpensive replacement for cement used in concrete, for it improves the strength, segregation, and ease of pumping of the concrete. Fly ash is also used as an ingredient in brick, block, paving, and structural fills.

BENEFITS OF FLY ASH CONCRETE

- Some manufacturer's proprietary fly ash cement is considered a non-shrink material with advantages in workability, water retention, and strength.
- Because fly ash mixes with less water, it is less likely to crack.
- Fly ash has low embodied energy and is an industrial by-product.
- Fly ash concrete is currently cost-competitive with Portland cement concrete.
- The material is somewhat lighter than Portland cement.
- Because fly ash cement requires less water than Portland cement, it is easier to use in cold weather.
- Fly ash can be substituted for traditional raw materials such as shale, clay, or sand.

CHALLENGES OF FLY ASH CONCRETE

- Fly ash comes from various operations in different regions, so its mineral makeup may vary among manufacturers.
- Fly ash may not be available in your area.
- There are some concerns about freeze-thaw performance and a tendency of mixes made with fly ash to effloresce or leave a powdery substance on the surface. This efflorescence happens especially when used as a complete replacement for Portland cement.

B. PRESERVED WOOD FOUNDATION (PWF)

Preserved wood with batt insulation can be used to construct foundation walls. The preserved wood is soaked in a salt solution and pressure-treated, making it less vulnerable to water and more adaptable to outdoor usage. A vapor and water barrier must be installed at the interface between the soil and the wood because the wood will absorb water, which can cause mold and insect invasion. The R-value for a 4' preserved-wood wall is around R-19 if 2 x 4 construction is used with a full-depth fiberglass batt. The average cost is about $8 per square foot.

BENEFITS OF PRESERVED WOOD FOUNDATION

- PWFs are dry, comfortable, easy to finish, and more economical to convert to fully livable space than masonry foundations.
- PWFs are easily insulated and finished, which reduces foundation heat loss by up to 50 percent without the added expense of extra studding or furring.
- Unlike concrete or block, a PWF does not allow moisture or dampness to pass through the foundation walls, virtually eliminating the cold, damp, and musty basement feeling and maximizing comfortable living space.
- A PWF can easily be plumbed and wired just like the rest of a house.
- The PWF is approved by the Canadian Standards Association (CSA) and meets all building standards. It uses only treated lumber and plywood bearing the CSA stamp.
- When building a PWF, you can reduce building costs by as much as $10 per square foot.
- A preserved wood system would be a good choice for a house in a rural area because wood is lightweight and easier to transport, store, and use than ready-mix concrete.

CHALLENGES OF PRESERVED WOOD FOUNDATION

- In the event of a hurricane, a tornado, or flooding, a wood basement is unlikely to perform as well as concrete blocks or other foundations.
- The walls have little thermal mass, and since the exterior soil is often moist, the relative humidity near the wall will often be 100 percent, even if water is not present.

C. INSULATED CONCRETE FORMS (ICF)

Insulated Concrete Forms (ICF) are constructed from expanded polystyrene and stacked like building blocks to form the exterior walls of a home; the forms are reinforced with steel and filled with concrete. The forms interlock and fasten to each other to provide seamless "foundation to rafter" insulated, reinforced concrete walls. Window and door openings of any size are possible. ICFs provide a lasting building envelope, designed to withstand high wind, fire, the elements, and the test of time.

IMPLEMENTATION OF INSULATED CONCRETED FORMS

Basement waterproofing materials for windows and doors for an ICF basement need to be ordered with wider jamb extensions to accommodate the increased wall thickness. The level of manufacturer support, including training, on-site and technical support, and marketing materials will vary between manufacturers.

BENEFITS OF INSULATED CONCRETE FORMS

- ICF construction is compatible with all home designs.
- ICF walls benefit from concrete's inherent structural qualities, particularly important in regions affected by severe weather.
- The combination of a continuous concrete wall and the integral interior and exterior insulation provides superb energy efficiency and lower utility bills.
- ICFs energy efficiency translates into even, consistent temperatures throughout the home. Outdoor pollutants can be kept to a minimum.
- With several inches of concrete sandwiched by foam insulation, ICF homes are typically quieter than conventionally built homes.
- ICFs save money, conserve resources, and use recycled materials.
- ICFs are not subject to rot and result in a better insulated foundation.

CHALLENGES OF INSULATED CONCRETE FORMS

ICF homes may cost up to 10 percent more to build, depending on the manufacturer, shipping costs, and other factors impacting local building costs. Lower heating and cooling loads will offset the increased up-front construction costs with lowered requirements for HVAC equipment and long-term utility savings.

D. FROST-PROTECTED SHALLOW FOUNDATIONS (FPSF)

A Frost-Protected Shallow Foundation protects against frost damage without the need for excavating below the frost line. An FSPF has insulation placed strategically around the outside of a foundation to direct heat loss from the building toward the foundation, and to use the earth's natural geothermal energy.

IMPLEMENTATION OF FROST-PROTECTED SHALLOW FOUNDATION

- One layer of insulation covers the outside face of the foundation, while a second extends horizontally away from it.
- The rigid foam traps any heat that the ground absorbs from the building, keeping soil temperatures around the footing above freezing.
- The building's heating system can be safely turned off for up to three weeks in the winter because thermal lag in the concrete will maintain the soil temperature above freezing.

BENEFITS OF FROST-PROTECTED SHALLOW FOUNDATION

- Saves energy.
- Cuts construction costs.
- The insulated footings can keep the soil above freezing even in the coldest weather.

CHALLENGES OF FROST-PROTECTED SHALLOW FOUNDATION

- In some areas it may be difficult to acquire permit approval.
- An FPSF is only cost-effective if the frost line is 30" or deeper.
- If you have a walkout basement and the grade comes down the sides of the house, you have to be aware of where dampproofing is required.
- You will need to train subcontractors about the importance of frost-protected insulation.

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Green and Red Construction in Guadalupe, Arizona

YouthBuild Guadalupe has constructed 27 new, affordable homes over the last seven years. In the small town with a population of just over 5,000 people, this new construction has greatly contributed to improving the housing stock. YouthBuild Guadalupe's latest effort is their first energy-efficient home. In 2006 they began deconstruction of an existing building and aimed to complete construction in August 2006. With a membership of 50 percent Native American and 50 percent Hispanic, this project aimed to build an energy-efficient home that reflects the local cultures. The project is getting interest from groups seeking to replicate the model, such as Habitat for Humanity, the Yaqui tribe in Tucson, Arizona, and the Mexican American community. In a short amount of time, it has proven to be quite successful.

Red Construction— A Culturally Conscious Design

The new home was incorporated the input of citizens from three community forums. To reflect Southwestern culture, YouthBuild members skinned log trees (referred to as "Vegas") for the supportive roof structure. A courtyard area was designed to perform as a outdoor family gathering space. The community requested buildings that serve multiple generations, and the design responded by creating a casita for rental income or a mother-in-law apartment—a small house with its own bathroom and kitchenette. The larger house was also constructed to structurally withstand a second story for an additional two bedrooms, to accommodate a growing family. The design also includes cut-outs, or enclaves in the wall system, to place statues or other items.

Green Construction— An Environmentally Conscious Design

The house is designed as a passive solar building to maximize the benefits and reduce problems of desert climate in its orientation and layout. The courtyard, in addition to making sense culturally, was designed to help cool the rest of the house. The home wraps around the courtyard on three sides forming a C-shape. A fountain cools the space, which in turn, along with the shading of indigenous plants, cools the house. The courtyard also features an outdoor cooking area because traditional Native and Hispanic cooking is done outdoors to help keep the house cooler.

The roof is enclosed with a mirror seal—a nontoxic white, reflective, elastomeric flat roofing system in lieu of rubber or petroleum based products—produced in Tucson by Innovative Solutions. Most roofs are highly toxic, but the youth are able to build this one and they don't need to hire highly qualified roofers certified to work with toxic material, as is the case with other toxic roofing materials. The roof reflects the sun as well so that it keeps the house cooler, another solar energy-efficient design.

Another energy-efficient feature is the unique air-conditioning system produced by Alter-Air, of Phoenix. It's a water cooled air chiller that uses no Freon, so it helps prevent prevents ozone layer depletion. The exhaust air from the Alter-Air cooling system is cooler than Freon-based air conditioning methods: It's no hotter than 80° (Freon air conditioning exhaust is well over 100°) and as a result they funnel the exhaust into the courtyard to keep it even cooler.

For a watering system, three cistern water tanks will collect rainwater for landscaping, up to 4000 gallons a year of rain.

Another green element is a Flex-Crete block locally produced on the Navajo reservation in Page, Arizona. The Flex-Crete product is a fiber-reinforced aerated concrete product that uses high volumes of fly ash. Fly ash is abundant where coal is burned during strip mining. The ash is combined with concrete, fiber, and aluminum chloride. This particular block gives a high "R" value, which measures insulation quality. Traditional building insulation quality is measured at R-19, and the Flex-Crete product provides up to an R-40 value. It is soundproof, fireproof, and termite-resistant. For more information visit www.flex-crete.com.

The deconstruction material from the original home was reused; the original concrete foundation was used as pavers throughout the courtyard. They also used the old plywood from the old carport for the new carport.

Contact Gail Acosta for advice on green and culturally-conscious building designs: gacosta@guatlupeaz.org.