precast solutions

Tech Brief - Foundations

Precast concrete foundation wall systems, recently approved by ICC, are quickly gaining popularity.

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Architects, homeowners, builders, developers and contractors are faced with a rather unique situation. There are now more choices in foundation materials for residential construction that are code compliant, cost effective, and of superior quality and durability. As of June 2007, the International Residential Code (IRC) has approved additional sections outlining the use of precast concrete foundation wall systems for homes in its 2007 Supplement.

Members of NPCA's staff and NPCA's Foundation Wall Subcommittee appeared before the International Code Council at a public hearing conducted May 22, 2007, in Rochester, N.Y. Along with the support of several industry code consultants and building experts, the team provided strong testimony and engineering data as to why precast foundation wall systems should be made part of the existing IRC.

Precast concrete foundation wall systems are relatively new and are growing rapidly in popularity. Building officials across the country are reviewing and approving precast foundation wall systems with mixed reaction. This is largely attributed to the fact that there was no specific language in the IRC supporting their use. Precast foundations have been included in the IRC for some time (first mention in 2000 and 2003). However, our efforts have expanded the description of this system in the code to make it easier for code officials. Modifications to the code were necessary to position precast foundation wall systems as an acceptable alternate to conventional foundation materials. Therefore, additional language was necessary to clarify the existing code to minimize confusion and hasten their approval by local building officials.

The highlights of the approved code revisions include minimum specifications; clarifying the use of concrete or crushed stone footings for precast foundations; and adding damp proofing issues specific to precast concrete foundations. The NPCA Foundation Wall Subcommittee has already proposed further code revisions in the 2007-2008 code cycle to include design criteria; drainage requirements; definitions; material requirements; and reference to durability standards (see IRC Sections R403, R404, R405 and R406 for details).

What are precast concrete foundation wall systems?

By definition, foundation walls are walls that extend below grade and rest on a footing or load-bearing material. The foundation wall must be able to transfer the weight (load) of the exterior walls and everything they support to the supporting soil and withstand the lateral forces applied by the exterior soil.

With modern construction, foundation walls are usually 8- to 10-inch-thick poured reinforced concrete or 8- to 12-inch-wide concrete masonry units (CMUs, or concrete blocks). The thickness of the wall is determined by the weight (vertical load), depth below grade (lateral load) and the material used. Other materials include brick, stone, cinder block, clay tiles and wood. Each has its own advantages and disadvantages.

Precast concrete foundation and wall panels can take many forms. Some consist of steel-reinforced concrete ribs that run vertically and horizontally in the panels, while others are solid. Precast panels are cured in a controlled factory environment, so weather delays can be avoided. A typical panelized foundation can be erected in four to five hours without the need to place concrete on site for the foundation. The result is a foundation that can be installed in any climate zone in one-sixth the time needed for a formed concrete wall.

Some manufacturers cast the concrete against foam insulation that provides the form during manufacture and added R-value in the wall. Panels range in size from 2 feet to12 feet wide and 8 feet to 12 feet in height and are typically installed on top of 4 inches to 6 inches of compacted stone with a crane. The stone facilitates sub-slab drainage and adequately carries and transfers the load from the foundation wall. Panel connections consist of bolts and sealant. The foundation can be backfilled as soon as it is braced per manufacturer's specifications.

The controlled temperature of the processing plant allows the manufacturer to work with concrete admixtures that focus on ultimate strength rather than cure time and temperature. Manufacturers are able to produce mixes that harden to 5,000 psi, which is stronger than concrete block or concrete walls formed and cast in the field. Better control of the concrete mixture and curing environment allows the use of low water/cement ratios that result in a dense material that prevents water penetration.

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The advantage goes to precast

Precast concrete technology has been around for years in the commercial construction industry, but only recently has it started to supplant traditional residential foundation construction methods. There are huge advantages in building with precast foundation components.

Traditional poured concrete foundations can be effective, but constructing them requires the absolute best foundation specialists. Here are a few things that can go wrong with traditional block or poured concrete foundation systems:

- A block foundation contractor may mix the mortar too weak.
- An inexperienced block layer may add water to stiff mortar and weaken it.
- The block foundation may not have any reinforcing steel in it.
- Poured foundation walls can have cold seams, in which one batch of concrete sets up while waiting for another truck to provide the next batch.
- The top of a poured-in-place foundation wall can be out of level.
- If the forms are not checked and braced before the pour, the foundation can be out of plumb and out of square.
- Many poured concrete walls have no vertical steel in them.
- Excessively cold or hot weather can harm concrete or block walls as they are built in the field.
- Inclement weather can stop the traditional foundation construction process in its tracks. Some installers have been known to charge more to overcome such conditions or reschedule construction activities, causing ultimate delays in occupancy.

Precast concrete foundation systems solve all of these problems and more. The fact that they do not require a concrete footer may come as a surprise to many. Virtually every roadway around the world uses crushed stone as a base. Railroad tracks are laid on crushed rock as well. Both of these support far more concentrated loads than the foundation of a home. If the soil beneath the foundation is weak, the builder can increase the depth and width of the crushed stone. Frank Lloyd Wright successfully used this method to support foundations on some of his projects.

The precast systems have appeal for many reasons. First, they are poured in controlled conditions in a factory. The concrete mix design of precast foundations is a minimum 5,000 psi in strength. Most poured-in-place walls use 3,500 psi concrete. Ready-mix trucks usually are required to deliver and place the concrete in less than 90 minutes from the time the batch plant deposits the mix into the mixer. If the batch begins to set inside the mixer, some drivers may attempt to add water in order to get the mix to flow properly. Quality of the mix should always be a top concern.

In contrast, precast walls are cured in the factory, so they are guaranteed to achieve the intended design strength. The precast concrete walls are poured square, because the formwork is maintained to achieve prescribed tolerances. Once assembled, the foundation will be plumb, level and square.

In addition, the precast systems usually have foam insulation built into the walls. This minimizes cold conduction problems in northern climates. Nailers can be incorporated in the walls that will provide a nailing surface for interior wall finish materials. For example, there is no need to build an additional wood interior wall to finish a basement.

Perhaps the best feature of a precast system is that it typically can be erected in less than a day. Once the crushed gravel base is in place, a crane and experienced crew can set the panels like a giant Erector Set. The wall panels can be manufactured in heights from 4 feet to 10 feet. Any shape or size foundation can be customized for a particular application. Window or door openings are easily included in accordance with the drawings. The panels are bolted together and waterproofed with special high-performance sealants applied to joints and surfaces as required in order to keep moisture out. By following the manufacturers' backfill and sealant recommendations, water will not infiltrate these foundation walls.

Environmentally speaking, precast foundation wall systems potentially provide a project with LEED points in the following areas:

- Optimize energy performance – components help moderate indoor temperature extremes via thermal mass and insulation applications.
- Building reuse materials – precast has a long life and can be reused when modifying designs for intended use.
- Construction waste management – diverting construction debris from landfill disposal by recycling concrete material.
- Recycled content – supplementary cementitious materials, such as fly ash, silica fume and slag.
- Regional materials – use of indigenous materials and reduced transportation distances (within 500 miles).

- Low-emitting materials – precast foundation walls, floors and ceilings provide low indoor air contaminant surfaces.
- Innovative wastewater technologies used in the manufacture of precast panels.
- Materials and resource credit – bio-based release agents.
- Innovative design credit – precast can be made to take on any shape, color or texture.

As precast foundations receive more global acceptance, permit approvals should not be an issue due to the recent changes to the IRC. Precast manufacturers are more than willing to assist in educating local officials and contractors should a problem arise.