Precast Primer

Contents

- MAPA Producers, 2-3
- Design Assistance, 4-6
- Precast Overview, 7
- High Performance Precast, 8-9
- Architectural Precast, 10-12
- Aesthetic Versatility, 13-15
- Envelope Design, 16
- Structural Precast, 17-20
- Hollowcore Precast, 21-22
- Specialty Precast, 23-24
- Joint Design, 25
- Construction Speed, 26
- Design Economy, 27-28
- Precast Resiliency, 29-30
- Risk Management, 31
- Precast Innovations, 32
- Specifying Precast Concrete, 33-34
- PCI Certification, 35
- Resources, 36

Version 2: November 30, 2013
Precast Primer

MAPA Producers

Brayman Precast
2900 South Noah Drive   Saxonburg PA 16056
Phone: 724-352-5600
Website: [http://www.braymanprecast.com](http://www.braymanprecast.com)
Contact: Ken DiBucci  k_dibucci@braymanprecast.com

Concrete Building Systems
9283 Old Racetrack Road
P.O. Box 48  Delmar DE 19940
Phone: 302-846-3645  Fax: 302-846-0266
Website: [http://www.cbs-incorp.com](http://www.cbs-incorp.com)
Contact: Walt O'Day  waltoday@cbs-incorp.com

Conewago Precast Building Systems
660 Edgegrove Rd.
P.O. Box 407   Hanover, PA 17331
Phone: 717-632-7722  Fax: 717-632-5045
Website: [http://www.conewago.com](http://www.conewago.com)
Contact: Dan Eckenrode  deckenrode@conewago.com

High Concrete Group, Inc.
125 Denver Road   Denver PA 17517
Phone: 717-336-9300  Fax: 717-336-9301
Website: [http://www.highconcrete.com](http://www.highconcrete.com)
Contact: KellyTetkoskie  ktetkoskie@high.net

Jersey Precast Corporation
853 Nottingham Road   Hamilton Township NJ 08638
Phone: 609-689-3700  Fax: 609-689-3797
Website: [http://www.jerseyprecast.com](http://www.jerseyprecast.com)
Bridge Products: Arch Bridges
Markets: Bridges & Transportation
Contact: Paul Dentel  p.dentel@jerseyprecast.com

Metromont Corporation
1650 Darbytown Road   Richmond VA 23231
Phone: 804-222-6770
Website: [http://www.metromont.com](http://www.metromont.com)
Contact: Robbie Nesmith  rnesmith@metromont.com
          Eric Denny  edenny@metromont.com

Newcrete Products - A Division of New Enterprise Stone & Lime Co.
8180 Woodbury Pike   Roaring Spring PA 16673
Phone: 814-224-2121  Fax: 610-625-8268
Website: [http://www.newcrete.com](http://www.newcrete.com)
Contact: Dennis F. Campbell  DCampbell@nesl.com

Northeast Prestressed Products LLC
121 River Street   Cressona, PA 17929
Phone: 570-385-2352  Fax: 570-387-5898
Website: [http://www.nppbeams.com](http://www.nppbeams.com)
Contact: Lori Koury  lkoury@nppbeams.com
Precast Primer

MAPA Producers

Oldcastle Precast Building Systems
1401 Trimble Road   Edgewood MD 21040
Phone: 800-523-3747   Fax: 410-612-1214
Website: http://www.oldcastlesystems.com
Contact: Monica Schultes  Monica.Schultes@oldcastle.com

The Shockey Precast Group
P.O. Box 2530   Winchester VA 22604
Phone: 540-667-7700   Fax: 540-665-3272
Website: http://www.shockeyprecast.com
Contact: Jason Reynolds  jreynolds@shockeyprecast.com

Slaw Precast
438 Riverview Road   Lehighton, PA 18235
Phone: 610-852-2020   Fax: 610-852-2098
Website: http://www.slawprecast.com
Contact: Bob Slaw  bob@slawprecast.com

Tindall Corporation - Virginia
P.O. Box 711   Petersburg VA 23804
Phone: 804-861-8447   Fax: 804-862-6353
Website: http://www.tindallcorp.com
Contact: Steve Zivkovic  stevezivkovic@tindallcorp.com

Universal Concrete Products Corporation
400 Old Reading Pike, Suite 100
Stowe PA 19464
Phone: 610-323-0700   Fax: 610-323-4046
Website: http://www.universalconcrete.com
Contact: Elizabeth Strohl  Elizabeth@UniversalConcrete.com

U.S. Concrete Precast Group
3369 Paxtonville Road   Middleburg PA 17842
Phone: 570-837-1774   Fax: 570-837-1184
Website: http://www.us-concreteprecast.com
Contact: Steve Kenepp  skenepp@us-concrete.com
Precast Primer

Design Assistance

In recent years, a trend toward early integration of the design-build process has created a Design-Assist process. It allows precasters to respond to client’s escalating demands for faster, more environmentally friendly construction and unified delivery with less risk of price escalation. Meeting these demands requires early and intense collaboration among the building team.

The architectural or structural precast concrete producer is selected based on its ability to:

- execute the specific project’s demands
- provide product and erection quality assurance through PCI Certification
- demonstrate the capability for the technical expertise needed by the design and construction team.

Significant benefits can be achieved if the contract also includes the supply and installation of the final products. Establishing the design relationship as early in the contract with the precaster will significantly improve the outcome of the project. Including the supply and installation of the final product along with the design assistance would only further the overall project success.

Benefits of design assist include:

- Development of concrete mixtures and finishes during the development process rather than going through a sample approval process after bid and award.
- Early, dependable, budget and schedule input from the precast supplier.
- Reduction of requests for information (RFIs) with the precast supplier participating with the design team.
- Preparation of erection drawings upon award of contract to the precaster, as well as creating a review process for shop drawings.
- Close coordination of the supporting and bracing structural system for the precast panel connections with the engineer of record.
- Efficient delivery and installation of precast concrete components due to close coordination between the construction schedule and the precast concrete production schedule.
- Earlier coordination of every activity that typically occurs in a bid-build delivery process after the award.
- Precasters’ detailed expertise provides expedited development of the design, with engineering innovations and scheduling improvements, while enhancing aesthetics and controlling budgets from conceptual design to project completion. Each element can maximize its cost effectiveness by taking advantage of precast concrete’s inherent performance characteristics.

To maximize the potential, these elements should be considered:

- Color and finish selection
- Mold fabrication
- Casting and finishing techniques
- Handling methods in plant and at site
- Connection concepts
- Locations of connections to structure
- Material costs
- Construction sequencing
Precast Primer

Design Assistance

Throughout the process, the precaster should be considered as a partner on the design team. This will impose a responsibility on the precaster to understand related construction materials that must interface with the precast concrete so details appropriate to all the materials can be developed.

The Design Assist process consists of four key components. The precaster can inform the design team when a specific precast concrete-related design decision should be made to maximize efficiency in the production process.

Schematic Design (SD)

The precast technical representative requires specifics about the design intent regarding aesthetics and functionality. These should include:

- Finishes desired and schedule of initial samples
- Massing of volume and aesthetic elements
- Load-bearing options or framing options
- Insulation values for panels
- Bay spacing and floor-to-floor heights
- Panel-size limitation and repetition capability
- Panel set-backs
- Schedule
- Budget limitations
- Other design requirements (fire ratings, seismic design, blast resistance, etc.)
- Delivery requirements (time restrictions, building access, site restraints, etc.)
- Erection requirements (crane positioning, staging areas, etc.)
- The schematic-design phase reviews options and finds the approach that best leverages the benefits of architectural precast concrete in an aesthetically appropriate, functional, and cost-effective manner.

Design Development (DD)

Based on the choices from the schematic-design phase, further refinement is accomplished in the design-development phase. Issues to be addressed comprise:

- Preliminary selections of color and texture for the exterior aesthetics.
- Selection between loadbearing and structure-supported panels.
- Consideration of a total-precast concrete structural framing system.
- Decision on using insulated architectural precast concrete panels.
- Final panelization scheme.
- Review of repetition patterns to determine final mold costs.
Precast Primer

Design Assistance

- **Delineation of special aesthetic requirements** (multiple colors and finishes, special shapes, window setbacks, ornamental pieces, thin-brick embedment, stone attachments, etc.)
- **Coordination of the structural design scheme** with the overall building design, including locations of panel connections and preliminary connection forces.
- **Selection of interior finishes** (as they impact connection details).
- **Evaluation of vertical stiffness of structural components** supporting panels.
- **Explanation of jobsite activity requirements and necessary coordination.**

**Construction Documents (CDs)**

In the Design Assist role, the precaster can confirm refinements of and additions to architectural elevations, sections, and dimensions to ensure they are in accord with earlier decisions and cost estimates.

The precaster will provide erection drawings and related calculations showing the loads and final forces from the connections to the structural frame and the connection load locations. The architectural drawings are completed in this phase. Details specific to the precast concrete may be completed on the precast-erection drawings rather than being incorporated into the architectural drawings. Interfacing details with adjacent materials such as glazing or other façade materials still have to be included in the architectural drawings so the other trades can be informed of the intended detailing.

**Construction Administration (CA)**

Product fabrication, delivery, and installation take place during this phase. The precaster’s role in this process includes:

- **Arranging plant visitations by the project team** to ensure the desired color, texture, and quality conditions are achieved.

**Page 6**

- **Preparation of mock-up panel(s)** for approval by the owner or design professional
- **Conducting job-site visits and participation in project meetings** to ensure smooth operations.
- **Monitoring installation and modifications to field conditions.**
- **Coordinating all handling and erection details.**
- **Creating a sequencing plan of erection components with the general contractor.**
- **Maintaining close contact with firms transporting and erecting precast concrete components (if not done by the precaster directly).**
- **Monitoring tolerances and alignment issues during installation.**
- **Addressing and closing out the design team’s punch list.**
- **Proposing a program of inspection and maintenance.**
- **Successfully executing a well-planned Design-Assist process ensures all project complexities have been discussed and resolved early in design and planning. This process can eliminate expensive modifications during construction.**
- **The benefits to the owner and design team are a cost-effective design with a time- and money-saving schedule along with optimum product quality and appearance.**
Precast Primer

Precast Overview

Precast Concrete Basics

Precast concrete consists of concrete (a mixture of cement, water, aggregates and admixtures) cast into a specific shape at a location other than its in-service position. The concrete is poured into a form, typically wood or steel, and cured before being stripped from the form, usually the following day due to high early strength additives. The components are then transported to the construction site for erection.

The components are reinforced with either conventional reinforcing bar or are prestressed with high-tensile strength strands that are prestressed in the form before the concrete is poured. Once the concrete has cured to a specific strength, the strands are cut (detensioned). As the strands attempt to regain their original untensioned length, they compress the bonded concrete, creating a compressive force. This “precompression” adds load-carrying capacity to the components and helps prevent and control cracking to specified limits allowed by building codes.

Key Components

Precast concrete components can be used in a multitude of ways to help design any type of structure. Key precast concrete components are:

- **wall panels**, which can include an enclosed layer of insulation sandwiched between interior and exterior wythes of concrete. The interior finished face can also be designed to building structural support loads;
- **spandrels**, which generally span between columns and can be used in conjunction with glazing or curtain wall systems on various building types;
- **column covers**, which often are used to provide a decorative architectural finish to structural columns in high-profile locations;
- **double tees**, so named due to the two extending stems perpendicular to the horizontal deck. These tees often are used for parking structures and buildings where long open spans are desired;
- **hollowcore planks**, which are long slabs in which voids run the length of the pieces, reducing weight without reducing the structural integrity;
- **structural pieces**, including columns and a variety of beam shapes;
What is High Performance Precast Concrete?

High-performance buildings are becoming essential to meet the increasing variety of owner demands, from economic to environmental to safety. Precast concrete can help designers meet these needs for high performance in a multitude of ways.

The United States Federal Government, in the Energy Independence and Security Act of 2007 (401 PL 110-140) defines a high-performance structure as one that “integrates and optimizes on a lifecycle basis all major high performance attributes, including energy and water conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.”

At the heart of this definition are two essential concepts:

- **Using materials and systems that integrate and optimize high-performance attributes.**
- **Looking at the facility’s total cost on a lifecycle basis rather than solely considering first costs.**

Although the Energy Independence and Security Act defined a number of high-performance attributes, precast concrete’s attributes can be summarized into three basic groups: Versatile, Efficient, and Resilient. Precast concrete is being used more often to help projects meet and exceed their high-performance goals, throughout design, construction, and operation.

As a highly engineered product, precast concrete can be mixed, cast, and cured to achieve specific performance characteristics as required by each project.

Buildings created with high-performance precast concrete offer excellent energy savings and long-term life-cycle performance. They provide functional resilience, low embodied energy, and a high-performance building envelope. High Performance Precast Concrete can often mean the difference between a 30-year life for a structure and a 75-year life.

High Performance Precast Concrete components offers a strategic blend of versatile, efficient, and resilient benefits:

<table>
<thead>
<tr>
<th>VERSATILE</th>
<th>EFFICIENT</th>
<th>RESILIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aesthetic Versatility</td>
<td>Site Efficiency</td>
<td>Structure Durability</td>
</tr>
<tr>
<td>Virtually any color, form, and texture</td>
<td>Minimal site disturbance</td>
<td>Long service life</td>
</tr>
<tr>
<td>Facade integration</td>
<td>Negligible waste</td>
<td>Barrier wall system</td>
</tr>
<tr>
<td>Historic compatibility</td>
<td>Accelerated construction</td>
<td>Functional resilience</td>
</tr>
<tr>
<td>Structural Versatility</td>
<td>Energy and Operational Efficiency</td>
<td>Multi-Hazard Protection</td>
</tr>
<tr>
<td>Load-bearing envelopes</td>
<td>Scalable performance</td>
<td>Storm resistance</td>
</tr>
<tr>
<td>Economical sections</td>
<td>Thermally efficient</td>
<td>Earthquake resistance</td>
</tr>
<tr>
<td>Long open spans</td>
<td>Low life-cycle costs</td>
<td>Blast resistance</td>
</tr>
<tr>
<td>Use Versatility</td>
<td>Risk Reduction</td>
<td>Life Safety and Health</td>
</tr>
<tr>
<td>Recyclable</td>
<td>Design assist</td>
<td>Indoor environmental quality</td>
</tr>
<tr>
<td>Deconstructive reuse</td>
<td>Reduced detailing and trades</td>
<td>Passive fire resistance</td>
</tr>
<tr>
<td>Adaptive reuse</td>
<td>Enhanced profitability</td>
<td>Meets FEMA 361</td>
</tr>
</tbody>
</table>

**Versatility**
- **Aesthetic diversity**, including the capability to integrate an almost endless array of colors and textures into a high-strength concrete face into which veneers and masonry can also be embedded.
- **Architectural plasticity**, allowing the designer to use formliners and custom forms to create shapes, patterns, and details than cannot be achieved with other materials.
- **Structural flexibility**, by providing long, open spans with reduced structural sections that eliminate columns and obstructions.
Precast Primer

High Performance Precast

**Scalable performance**, ensuring buildings can quickly adapt to any type of insulation thickness or other variable within the building envelope. This is really an efficiency attribute.

**Space planning flexibility** through using long-span capabilities to create open floor plans and easier adaptations for new tenants or retrofits.

**Efficiency**

**Controlled production** at an offsite facility, minimizing construction site space demands while maximizing quality.

**Multiple finishes** in one panel, reducing detailing, joints, flashing, onsite labor, and maintenance costs.

**Combination architectural and structural components**, which allow faster erection of the building shell, reduced onsite activities, and focused responsibility in a single-source supplier.

**Fast delivery and erection**, requiring no staging area for just-in-time deliveries and no delays for cold weather conditions.

**High thermal mass**, which helps reduce overall life-cycle costs, especially energy usage required to heat and cool the building.

**Reduced life-cycle costs** due to reduced long-term costs for maintenance and utilities, elimination of mortar joint in brick facades, and fewer building joints.

**Compatibility with green building codes and standards**, including compliance with the performance-based requirements of the International Green Construction Code, ASHRAE 189.1, and LEED v4.

**Resiliency**

**Storm protection** from high winds and flying debris, proven with impact studies. Precast concrete also resists storm surge and is widely used in FEMA 361 storm shelter compliance.

**High seismic protection**, including innovative, code-approved techniques to self-right a structural frame following a seismic event.

**Fire protection** due to precast concrete’s inorganic composition and capabilities to provide a passive protection system.

**Blast protection**, including meeting federal Anti-Terrorist/Force Protection requirements with only minor modifications to connection details.

**Enhanced indoor environmental quality (IEQ)**, which results from inhibition of mold growth and its ability to not rot, rust, or degrade as well as providing extremely low emission of volatile organic compounds (VOCs).

**Improved acoustics**, including very high sound transmission coefficient ratings, due to its high density that dampen noise.
Precast Primer

Architectural Precast

Precast concrete manufacturers can fabricate a multitude of architectural pieces to clad any type of building. These pieces can be finished in almost any way to create attractive appearances or to replicate the look of stone, masonry and other textures. They can use veneers, embedded brick or stone or formliners to create the final appearance.

The key components that are cast with an architectural finish include:

**Wall Panels**

Wall panels can be strictly architectural, strictly structural or both. They can be placed in either a horizontal position as in a multifamily-housing application or in a vertical position as in warehouse exteriors. Wall panels can be load bearing, supporting floor and roof components without a separate framing system, or they can be non-load bearing to complete a facade.

**Typical widths**: 4 to 15 feet.

**Typical heights**: 8 to 50 feet.

**Typical thicknesses**: 5 to 12 inches.

**Casting process**: Wall panels can be made in a long-line pretensioning facility and reinforced with prestressing strand or cast in individual forms with either prestressing strand or conventional rebar. They are cast in a horizontal position and rotated to their final position at the jobsite by the erection crew.

**Finishes**: Wall panels are cast in a flat orientation, so the form side typically is exposed to view in the final construction. This face can be made with virtually any type of finish. The back face is typically troweled smooth or may have a light broom finish.

**Insulated Sandwich Wall Panels**

These panels have similar characteristics to standard wall panels except they are cast with several inches of rigid insulation “sandwiched” between two layers of concrete, called wythes. The insulation thickness can vary to create the desired thermal insulating property ("R" value) for the wall.

The structural behavior is either:

**Composite**, in which the wythes are connected with ties that do not compromise the insulation layer’s energy efficiency. The structural performance is then based on the full thickness of the panel.

**Non-Composite**, in which the wythes are connected using ties through the insulation, which limits performance to the individual capacities of each Wythe.

Whether the panel is composite or non-composite depends on the configuration and material used for the ties. When insulated sandwich wall panels are designed to be load-bearing, they typically are cast with a thicker interior Wythe (as small as 3”-2”-3”) to provide the necessary support. Non-composite panels are normally thicker.

**Typical widths**: 4 to 15 feet.

**Typical heights**: 8 to 50 feet.

**Typical thicknesses**: 8 to 14 inches, including 1 to 3 inches of insulation, more for applications requiring higher insulation levels for greater efficiency.
Precast Primer

Architectural Precast

Insulated Sandwich Wall Panels, continued

Casting process: The panels are cast similar to typical panels, in a horizontal position. Typically, one Wythe of concrete is poured, the insulation is placed and the second layer is poured. They are then rotated to their final position at the jobsite.

Finishes: The panels’ front faces are finished similar to standard wall panels. The back face is typically troweled smooth or may have a light broom finish, as it serves as the interior wall for rooms. Typically, the interior does not need additional furring and drywall.

Spandrels

Spandrels are perimeter beams that extend both above and below the floor and are used most often as cladding on office buildings and similar structures around window units, as well as for structural support on deck components in parking structures. They are typically made as:

Load-bearing with a ledge, as in parking structures’ supporting double tees or in office buildings supporting hollowcore slabs.

Load-bearing with pockets, as in support for double tees, where the stem of the double tee fits into a pocket cast into the thickness of the spandrel.

Non-load-bearing as in cladding for any type structure, typically with curtain wall or glazing.

Spandrel panels can be created in any size that is required to satisfy structural requirements.

Typical heights: 5 to 8 feet.

Typical spans: 25 to 60 feet.

Typical thicknesses: 5 to 12 inches, depending on the structural requirements.

Casting process: Spandrels are cast flat with the side to have the most prominent exposure cast face down to form the exposed surface. They can be reinforced either with prestressing strand or conventional rebar. They can be cast in a long-line pretensioning facility similar to double tees or in individual forms.

Finishes: The exposed face can be made with virtually any type of finish. The back face is typically troweled smooth or may have a light broom finish.

Column Covers

Column covers typically are used to clad columns that serve as a major focal point. They may be broad or barely wider than the column itself and run vertically up a structure. They often conceal structural columns and may completely surround them at the ground level. They typically are supported by the structural column or the floor and are designed to transfer no vertical load other than their own weight. The vertical load of each length of column-cover section is usually supported at one elevation and tied back at the top and bottom to the floors for lateral load transfer and stability.

Casting process: Column covers typically are cast as single-story units, although units two or more stories in height can be cast to minimize erection costs and horizontal joints. They are cast in a horizontal position and rotated to their final position at the jobsite by the erection crew.

Typical shapes: C or U shaped (matching halves cover a structural column).

Typical sizes: One story tall.

Finishes: The exterior three sides of the column cover can be finished in any way desired similar to an architectural precast concrete panel.
Mullions

Mullions are thin, often decorative pieces that fill open space in a building façade. They often are isolated elements forming a long vertical line, requiring them to be cast perfectly straight to avoid any visual deformities.

Sizes and shapes can vary to satisfy both architectural and structural requirements.

**Typical shapes:** Square or rectangle.

**Typical sizes:** Up to one story tall, but longer mullions can be made.

**Finishes:** Three of the four sides are created with a form, as they are cast in a horizontal position. They can be finished in a variety of ways, depending on the application and the architectural purpose.

**Casting process:** They can be made in a long-line pretensioning facility and reinforced with prestressing strand or cast in individual forms with either prestressing strand or conventional rebar. They are cast in a horizontal position and rotated to their final position at the jobsite by the erection crew.
Aesthetic Versatility

High Performance Precast Concrete offers inherent aesthetic versatility due to its capabilities to be cast and finished in a variety of ways. Architectural finishes can be designed to blend with a building’s surroundings or architectural context, whether those are historic or contemporary, or they can be created to make a unique statement.

These capabilities allow High Performance Precast to provide the natural beauty of other types of materials while adding all of the performance benefits of precast concrete.

Panel Aesthetics

The variety of aesthetic options for architectural panels can be changed through any of these factors:

- choice of aggregates
- choice of matrix color
- water-cement ratios
- sandblasting variations
- formliners
- embeds
- blockouts and reveals
- cutouts for later attachment of veneers
- finish techniques
- acid etching
- staining

Precasters can supply full-sized sample panels finished in accordance with planned production techniques. These samples ensure the desired aesthetic treatment will be achieved and can be tweaked prior to erection, giving owners and designers more control over the finished appearance.

Finishes

The variety of textures that can be achieved for precast concrete components allows the naturalness of the concrete ingredients to be expressed, provides scale to the mass, expresses the plasticity of the concrete, and improves weathering characteristics. Three levels of exposure create the finished appearance:

- **Light exposure** involves removing only the surface skin of cement and sand. This sufficiently exposes the tips of the closest coarse aggregate.
- **Medium exposure** requires further removal of cement and sand to cause the coarse aggregates to visually appear approximately equal in area to the matrix.
- **Deep exposure** requires cement and sand to be removed from the surface so the coarse aggregates become the major surface feature.
Aesthetic Versatility

Finishes, continued
A wide range of other precast concrete surface finishes are available. The most common are:

- **Smooth or off-the-form finish.**
- **Tooling, spalling or chipping, usually called bushhammering.**
- **Hammered-rib or fractured-fin design.**
- **Sand embedment.**
- **Honing or polished finish.**

Embedded Thin Brick
Virtually any clay product can be embedded into precast concrete panels, including brick (typically thin bricks), ceramic tile, and terra cotta. The products can cover the entire exposed panel surface or only a portion, serving as an accent band or contrasting section. Embedded thin brick offers several advantages over site laid-up masonry. These include:

- elimination of onsite scaffolding and trades.
- secure connection to the panel due to embedment in the concrete rather than framing with a thin layer of mortar.
- fast erection due to brick already being installed when panels arrive at the site.
- no delays for harsh weather or cold-weather procedures that slow masonry work.
- single-source responsibility for panels and brick facing.
- consistent quality of material and labor
- Variety of mortar joint appearance options (mortar joint is actually the body of the precast concrete panel)

Handling and erection of brick- or stone-embedded panels are similar to other precast concrete wall panels, providing fast erection and quick enclosure of the building while eliminating post-erection facing needs.

Thin bricks are ¾” thick engineered masonry products, of the same composition as standard dimensional masonry. Thin bricks are engineered to tight tolerances so they fit tightly into standard forms, reducing the potential for “bleeding” around the forms during pouring.

Multiple Finishes
Design flexibility in color and texture in High Performance Precast Concrete panels can be enhanced by combining multiple finishes and aesthetic treatments in one panel. This approach provides several benefits, including:

- reduced number of pieces to cast.
- minimized site labor.
- less detailing.
- fewer joints to maintain.
- single-source responsibility for entire façade.
Aesthetic Versatility

Formliners

Formliners are molds placed into the form to produce a decorative or designed finish on the panel face. Typically, these molds replicate the look of cut stone, brick or other textural surfaces, even wood. They often are created using the original materials to form the mold, which is then used to transfer the pattern to the front of the panel.

They also can be used to create lettering, symbols or logos in panels, as well as ribs or flutes and other geometric shapes.

Formliners can be created from a multitude of materials, including wood, steel, plaster, elastomeric, plastic or polystyrene foam. They can be reused or changed in position when designed appropriately to create a random look that simulates natural patterns.

New formliner techniques allow the transfer of photographic images to rubber forms that can be used to produce the image into the finished precast panel.

Interior Finishes

The interior side of architectural precast concrete panels also can be given an aesthetic finish, eliminating the need to provide an additional finished wall. This can save materials, time, and cost. Finish options include:

- **screed**
- **light broom**
- **float**
- **trowel**
- **stippled**

High Performance Precast Concrete offers great versatility for using color, texture, embedded materials, formliners, and multiple colors. These capabilities give designers an almost unlimited palette from which to achieve a specific look or statement for the client that will last through the entire service life of the project.
Precast Primer

Envelope Design

Precast concrete provides an efficient, versatile and resilient envelope system. Precast walls systems, are barrier, or face-sealed systems. Unlike rainscreen systems, precast concrete does not require a cavity where moisture collects and other problems can occur. The following factors are important elements of precast envelope design:

**Thermal Performance**
- R-Value calculation
- Continuous insulation
- Thermal bridging
- Thermal Mass

**Air and Moisture Management**
- Air barriers and retarders (IECC 2012)
- Vapor retarders and barriers
- Condensation and dew point analysis
- Avoidance of mold

**Integration of Systems**
- Interfacing details
- Joint details
- Tolerances
- Panelization

---

**Key Precast Envelope Factors**

**Low permeability**
3” constitutes a code-compliant vapor retarder

**Sandwich wall low conductivity**
Glass fiber or carbon fiber connectors reduce thermal bridging

**Thermal Mass**
The thermal mass of concrete reduces and delays peak loads, allows downsizing of HVAC equipment

**Joints**
Precast envelope systems have fewer lineal footage, and more thermally-efficient joints, than cavity wall or metal panel construction.

**No Cavity**
Precast sandwich wall panels consist of edge-to-edge insulation bonded between two wythes of concrete. No potential for mold growth or condensation. Precast sandwich walls typically do not require a vapor barrier.

**Low Thermal Expansion**
6000 psi concrete has low expansion and contraction, so differential movement problems are almost always controlled via the panel joints.
Precast concrete components can be joined in a variety of configurations to create an all-precast concrete structural system for a building. When combined with architectural precast concrete panels (or load-bearing panels, which eliminate some framing members), these pieces provide a complete building shell that provides single-source responsibility.

Such an approach to the building envelope can improve communication, reduce construction time, minimize site disturbance, and maximize cost efficiency. The major components typically used in such framing systems include:

**Beams**

Beams are horizontal components that support deck members like double tees, hollow-core and solid slabs and sometimes other beams. They typically are made in one of three shapes:

- **Rectangular**
- **Inverted Tee Beams**
- **L Beams**

They can be reinforced with either prestressing strand or conventional reinforcing bars. This will depend on the spans, loading conditions and the producer’s preferred production methods.

**Casting process:** Prestressed beams are typically pretensioned and cast in a long-line set up similar to that used for double tees. Beams that are reinforced with conventional rebar can be cast as individual components, in shorter forms made specifically for the size of the beam. They are typically cast in the same orientation as used in the final structure.

Beams can be cast in practically any size needed to satisfy structural requirements.

**Typical depths:** 16 to 40 inches.

**Typical widths:** 12 to 24 inches.

**Typical span to depth ratios:** 10 to 20.

**Finishes:** Since beams are cast upright, the bottom, sides and ledges are cast against a form and will typically be provided with an “as cast” finish that results in a smooth, hard finish. The top is troweled by the finishing crew and can be smooth, roughened to simulate the finish of supported double tees (as in a parking structure) or intentionally roughened to create a bond with cast-in-place concrete that may be poured on top of it.
Precast Primer

Structural Precast

Columns

Columns are typically used to support beams and spandrels in applications such as parking structures and total-precast concrete structural systems of all types. They typically are designed as multilevel components ranging from a single story to six levels or more.

Casting process: They can be made in a long-line pretensioning facility and reinforced with prestressing strand or cast in individual forms with either prestressing strand or conventional rebar. They are cast in a horizontal position and rotated to their final position at the jobsite by the erection crew.

Sizes and shapes can vary to satisfy both architectural and structural requirements.

Typical shapes: Square or rectangle.

Typical sizes: From 12 by 12 inches to 24 by 48 inches.

Finishes: Since columns are cast in a horizontal position, three of the four sides are created with a form. These finishes are very smooth and most often remain “as cast” in the finished construction. The fourth side is typically troweled to match the other three sides as closely as possible.

Shear Walls

Shear walls act as vertical cantilever beams, transferring lateral forces acting parallel to the face of the wall from the superstructure to the foundation. Typically, there are two shear walls oriented to resist lateral loads along each principal axis of the building. They should be designed as load-bearing panels.

Typical widths: 15 to 30 feet.

Typical heights: 10 to 30 feet depending on the width and transportation limitations.

Typical thicknesses: 8 to 16 inches.

Casting process: Shear walls typically are cast flat in an individual form and reinforced with conventional rebar. They are cast in a horizontal position and rotated to their final position at the jobsite by the erection crew.

Finishes: Since shear walls are cast in a flat orientation, one side is finished in the form and the other side is manually finished. Typically, they receive the same finish and a complementary style to the surrounding structure, especially in a parking structure, where they will be visible.

Solid Slabs

Solid slabs are used as structural deck components similar to hollow-core slabs.

They can be made in a long-line pretensioning facility and reinforced with prestressing strand or cast in individual forms with either prestressing strand or conventional rebar. They are typically cast in the same position as used in the structure.

Sizes can vary to satisfy the structural requirements.

Typical width: 4 feet

Typical spans: 8 to 30 feet.

Typical thicknesses: 4 to 12 inches.
Precast Primer

Structural Precast

Lite Walls

Light or “lite” walls are shear walls used in parking structures cast with an opening in their center to provide visual continuity and to allow daylight or artificial illumination to penetrate deeper into an interior. The components provide openness and a feeling of security. These support structures should not be confused with “light wells,” which are internal, open courtyards that provide daylight to the center of buildings.

As with other types of shear walls, lite walls serve as the lateral force-resisting systems in the structure. They act as cantilever beams, transferring lateral forces acting parallel to the face of the wall, from the superstructure to the foundation.

Casting process: They are cast in individual forms with either prestressing strand or conventional rebar. They are cast in a horizontal position and rotated to their final position at the jobsite by the erection crew.

Sizes and shapes can vary to satisfy both architectural and structural requirements.

Typical shapes: Rectangular with rectangular openings to create openness.

Typical sizes: 12 to 16 inches in width greater than the stem-to-stem spacing of the supported double tees.

Finishes: Lite walls are cast in a horizontal position, with three of the four sides created with a form. These finishes are very smooth and most often remain “as cast” in the finished construction. The fourth side is typically troweled to match the other three sides as closely as possible.

Hollowcore Slabs

Hollowcore slabs are used predominantly for floor and roof deck components for various structures including multi-family housing, hotel and condominiums, office buildings, schools and prisons.

Typical widths: 2, 4 and 8 feet; some precasters offer 10- and 12-ft widths.

Typical depths: 6, 8, 10, 12, 15 and 16 inches.

Typical span to depth ratios: Floors: 30 to 40; Roofs: 40 to 50

Casting process: Hollowcore slabs typically are cast in 300- to 500-foot-long prestressing facilities with at least one system making the slabs in 60-foot-long self-stressing forms that circulate through a production cycle. The long-line method consists of a proprietary machine specific to the brand, which extrudes the concrete and creates the voids by means of either a rotating auger or by placement of aggregate filler that is later removed.
Precast Primer

Structural Precast

Hollowcore, continued

**Finishes**: The form side (bottom) is smooth as cast and typically remains that way in the finished construction. It is usually an exposed-to-view surface and is often painted. The top side also is usually smooth and can remain as such for direct carpet applications. It also can be kept slightly rough to receive a composite cast-in-place structural topping of 2 to 3 inches or more. Topping thicknesses vary depending on application and design criteria.

**Branded Processes**: Each producer of hollowcore slabs uses a trademarked process that creates different shapes to form the voids within the pieces.

**Double Tees**

Double tees are used primarily as deck floor and roof components for any type of structure, including parking structures, office buildings, and industrial buildings. They are made either:

- **Pretopped** using a flange thickness of 4 inches, which creates the wearing surface in parking structures.

- **Field-topped** with a 2-inch flange, on which a cast-in-place concrete composite topping of 2 to 4 inches is added in the field. For roof construction, there is typically no need to add topping on the 2-inch flange.

Double tee lengths are expanding as new techniques are being employed to provide added strength and durability.

- **Typical widths**: 8, 10, 12 and 15 feet.
- **Typical depths**: 24, 26, 28, 30, 32 and 34 inches.
- **Typical span to depth ratios**: Floors: 25 to 35; Roofs: 35 to 40

*Double Tees can be made up to lengths of 90’ - 100’ — or larger—to create a longer clear span.*

**Casting process**: Double tees typically are cast in 300- to 500-foot-long prestressing facilities that are sub-divided into specific length tees for a particular project.

**Finishes**: Form side will generally be “as cast,” resulting in a smooth, hard finish. This generally remains as is and is not painted, although it can be if desired. The top-of-flange side will be smoothed for roof construction, left rough if it will receive a field topping or broom finish (either transversally or longitudinally) or circular swirl-finished if it will be used as the wearing surface in a parking structure.
Precast Primer

Hollowcore Precast

Hollowcore planks are used predominantly for floor and roof deck components for various structures such as residential, hotel, office buildings, schools, and prisons. Hollowcore provides exceptional sound transmission and impact insulation ratings, passive fire protection, and water damage resistance.

Typical widths: 2, 4, and 8 ft; 4 foot widths are most common.

Typical depths: 6, 8, 10, 12, 15, and 16 in.

Fire Ratings: 1-1/2 hr for 8” and above restrained; up to 4 hours for restrained with 3-1/8” topping

STC Ratings: 50 and above (with concrete topping)

IIC Ratings: for 8” thickness: 28 (with conc topping); 73 (with topping, carpet & pad)

<table>
<thead>
<tr>
<th>Plank Depth</th>
<th>Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>6”</td>
<td>20 ft</td>
</tr>
<tr>
<td>8”</td>
<td>30 ft</td>
</tr>
<tr>
<td>10”</td>
<td>35 ft</td>
</tr>
<tr>
<td>12”</td>
<td>40 ft</td>
</tr>
<tr>
<td>16”</td>
<td>50 ft</td>
</tr>
</tbody>
</table>

Note: Each producer of hollow-core slabs uses a trademarked process that creates different shapes to form the voids within the pieces. Information on the key types of hollow-core and the signature shapes produced by each process can be found in the PCI Design Handbook 7th Edition. Load tables and span charts can be found on the PCI website via a link located under Design Resources.

Typical Hollowcore Cross-sections
**Precast Primer**

**Hollowcore Precast**

Hollowcore Specification Information

**Fire Rating**

- The fire rating requirement should be clearly specified in the contract documents.

**Loading Conditions**

- Specify all uniform loading requirements on structural plans.
- Identify line and point loads resulting from load-bearing walls, metal-stud walls, masonry walls, face brick, columns, mechanical equipment, etc.
- Identify diaphragm forces and lateral loads resulting from wind or earth pressures.
- Review roof plans for vertical protrusions such as parapets, penthouses and adjacent buildings that could require designing for snow drift loads.

**Typical Hollowcore Bearing Examples**

- Plank supporting stairs require special loading considerations.
- Large openings or closely spaced groups of smaller openings will reduce the plank load carrying capacity.

**Topping**

- Specify whether or not concrete topping is to be composite. Composite action requires the topping to be bonded to the top surface of the plank. Topping separated by a vapor barrier or insulation is noncomposite and must be considered a superimposed load.
- Large cambers resulting from long spans and/or heavy loads will affect the quantity of topping, assuming a level floor is required. Two inches of composite topping at mid span is minimal, and additional thickness at the ends of the plank may be required to maintain level floor elevations.

**Camber**

- Camber is inherent in all prestressed products. It is the result of the eccentric prestress force required to resist design loads, and cannot be designed in, out, or to an exact number. The amount of camber will depend upon the span, design loads and thickness of plank. Planks stored in the yard for more than 6 weeks, usually due to construction schedule changes, will experience more camber growth.
- Adjacent plank of dissimilar length, strand pattern or with openings will have inherent camber differences.
Precast Primer

Specialty Precast

Precasters can fabricate components for a variety of specialty needs. The high-quality manufacturing process, off-site production, and fast erection on the jobsite provide efficiencies that make these uses a growing part of the industry. Dominant products include:

Stairs

Precast stairs are used in any application where a stair tower or individual stair units are required. These modules can provide fast erection and durable access in buildings or parking structures.

Typical thicknesses: 6 to 10 inches.

Casting process: They are typically made as “open-Z” stair components, in which the upper and lower landings are cast monolithically with the tread/riser section. They also can be cast as shorter components, consisting of only the tread/riser section, which is supported by separate landing components that span transversely to the stair section.

Stair components are typically cast either “on edge” or “upside down.” The format will depend on the size and the producer’s preferred production method. Abrasive nosing pieces are often cast into the treads to create a non-slip surface.

Finishes: When cast on edge, the tread and bottom remain as cast and typically will remain as such in the final construction. When they are cast upside down, the bottom will be troweled to the desired degree of smoothness and typically will remain exposed to view in the final construction.

Stadia & Arena Components

Precast concrete components can be used in a variety of ways for stadium projects, including facades, interior passageways (called vomitories), and structural systems including beams and columns. Precast concrete stadium seating is a popular option because of their fast erection without disrupting the site with falsework and added crews over long periods. Two key components comprise these seating sections:

Raker beams are angled, notched beams that support stadium riser units. They are used universally in outdoor stadiums and arenas and in many indoor arenas and performing-arts theaters.

Typical sizes: Sizes can vary as required structurally and to match varying riser sections that they support.

Typical widths: 16 to 24 inches.

Casting process: Raker beams are cast either upside down, on their side or upright, depending on the manufacturer’s preference. Any casting position will result in a favorable solution. Typically, three sides will have an “as cast” finish that results in a smooth, hard finish. The fourth side is troweled by the finish-
Stadium Risers

Stadium risers are used to support seating in stadiums, arenas, theaters and other types of grandstands. Typically, they are made as single, double or triple risers with heights cast to satisfy site lines in the venue. Specifying single, double or triple risers will depend on the layout and may be dictated by weights and crane access during construction.

**Typical spans:** 8 to 50 feet.

**Casting process:** Risers are typically cast in self-stressing forms made for each specific project, with up to three pieces being cast at one time, depending on the individual lengths. The bottom and vertical sections of the riser are cast against the form and typically will remain as cast in the final construction.

**Finishes:** The top (wearing surface) is typically troweled to the desired degree of smoothness or made slightly roughened to create a non-slip surface.

---

Modular Units

Precasters can produce modular precast concrete units that include a roof, floor, front and back walls plus two side walls if desired. The modules’ key benefit, in addition to the speed with which these “building blocks” can be erected on site, comes from the precaster being able to outfit and finish the modules at the plant so they arrive at the site nearly complete.

These modules are used for a variety of applications where relatively small, repetitive rooms are needed on a rapid schedule. Typical uses include:

- **prison cells**
- **classrooms**
- **hotel and motel rooms**

The modules can be single- or multi-level structures as high as 10 to 12 stories. In prison applications, the modules are cast as single- or multi-cell units with as many as four cells in one monolithic component. The configuration typically includes the inmate cell and a vertical “chase” between cells for mechanical, electrical and plumbing accommodations.

Typically, the interior exposed walls are epoxy painted, and the module is outfitted with as much of the MEP accommodations as possible in the producer’s plant. Final fit up is done at the jobsite. Exterior walls can be made with insulation similar to a sandwich wall panel and can receive virtually any kind of architectural treatment.

**Casting process:** Specialized, often proprietary, steel formwork is used, with mechanisms that adjust and “strip” the module from the form. These often are proprietary to the manufacturer. The special forms allow all wall surfaces to be cast against a form. When stripped from the form, the floor or roof surface is troweled to the desired degree of smoothness, and the wall surfaces are typically prepped to fill bug holes before painting.

**Finishes:** Typically, the interior walls of the inmate cells are sandblasted, any bug holes are filled and they are epoxy-painted before installation of items mentioned above.
Precast concrete systems require careful attention to joint design, for both aesthetic and maintenance purposes. Exterior precast joints typically consist of an exterior sealant and backer-rod joint combined with a similar interior joint. The exterior joint is subject to weather and temperature fluctuations, and should be formed with high performance sealant and inspected every few years for deterioration.

Floor joints can pose particular design constraints, as they must often be flush with the precast product for finish purposes. In hollowcore design, the plank joint must be grouted to provide a composite structural system.

Key Joint Design Considerations

- **Fire Protection**: Where the precast wall is part of a fire-resistant barrier, use ceramic fire felt of the required thickness to obtain the desired fire rating.

- **Continuous Insulation**: To maintain continuous insulation at the exterior envelope, utilize rigid insulation or mineral wool between the sealant barriers.

- **Interior Protection**: Where the interior wythe of a precast sandwich panel is also utilized as the interior finish, consider installing tamper-proof sealant or a finished tee insert to protect the interior sealant joint from damage.

### Panel Thickness (in.)

<table>
<thead>
<tr>
<th>Joint width = 3/8 in.</th>
<th>Joint width = 1 in.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 hr</strong></td>
<td><strong>2 hr</strong></td>
</tr>
<tr>
<td>4</td>
<td>1/4</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>

*Panel equivalent thicknesses are for carbonate concrete. For siliceous aggregate concrete, change “4, 5, 6, and 7” to “4.3, 5.3, 6.5, and 7.5”. For sand-lightweight concrete, change “4, 5, 6, and 7” to “3.3, 4.1, 4.9, and 5.7” respectively.

The tabulated values apply to one-stage joints and are consecutive for two-stage joints. Interpolation may be used for joint widths between 3/8” and 1”.

N.A. = Not applicable
Precast Primer

Construction Speed

Speed to Occupancy

Many of precast concrete’s attributes and technologies ensure the design and construction process move quickly and smoothly. These come into play at each stage of the process:

Design

The repetitive nature of precast concrete panels and components allow design work to move more quickly to the shop-drawing stage. Precast components also can aid a fast-track design by completing drawings while other design work is still underway.

Fabrication

Precast concrete components can begin casting as soon as drawings are completed and while site preparation and construction of foundations begins. Casting and storing components ensures they are ready for delivery as soon as the site is ready.

Scheduling

Because precast concrete components are fabricated under factory-controlled conditions at the plant, harsh winter weather does not impact the product schedule or product quality. This eliminates the need for cushions in the timetable to accommodate unforeseen delays due to weather. Thus, interior trades can begin work earlier, which can be critical as winter approaches.

Construction

Erecting precast concrete components can be achieved quickly, using just-in-time delivery or pulling them from a nearby staging area in the sequence best designed to complete erection quickly. Factory production also provides tight tolerances, minimizing field adjustments.

Interior Completion

Precast concrete insulated sandwich wall panels provide a finished interior wall that avoids the time and cost of furring and dry-walling while offering energy efficiencies. The entire wall assembly can be constructed with one trade compared to up to seven for a typical wall assembly. Using hollow-core planks to create combined Ceiling and flooring units speeds construction more.
A variety of cost calculations are required to determine what design approaches will most effectively achieve the owners’ goals. Initial in-ground costs are the most obvious expenses, but hidden and longer-term costs are also significant and can be greatly impacted by design decisions.

Projects should be considered holistically, understanding that each system and decision impacts others. All products and systems should be designed to work together to enhance each other without creating redundancy or inefficiencies.

The three key types of costs are:

**In-Ground Cost**

Initial or in-ground costs are typically the driving force when determining budgets and where to allocate funds. Precast concrete components provide a variety of savings in ways that are not always considered. These savings include:

A. **Speed of design and construction**, which can be saved through:
   - *the design process*, because precast requires less façade detailing and engineering details are provided by the precaster.
   - *the fabrication process*, which can progress while permitting and foundation work are underway. As a single-source supplier for a large portion of the structural system, precasters help maintain the critical-path scheduling.
   - *the erection process*, during which precast concrete components are set and connected rapidly, cutting weeks or months from the schedule. This speed allows construction to get into the dry quicker, giving interior trades access more rapidly.
   - *the finishing process*, especially with precast concrete insulated sandwich wall panels, which create a finished interior wall that eliminates the time and cost of drywalling. Architectural panels can have a variety of colors and textures, eliminating the need to field-set trim pieces or paint the facade.

B. **Design economy**, which can be achieved with architectural precast concrete panels through:
   - Selecting economical aggregates and textures.
   - Using repetitive units and effective production and erection details.
   - Limiting the number of pieces (rather than the size of each).

C. **Material Efficiency**, which can be achieved by using precast concrete components for several functions, such as:
   - using hollowcore planking and double tees as combined ceiling/flooring units
   - using spandrel panels in parking structures as vehicle-impact restraints.
   - using load-bearing precast concrete walls and hollowcore planks or double tees to create the framing and cladding system together.
   - using embedded thin brick or formliners to create a brick-like appearance, eliminating labor costs.
   - using textures and finishes to replicate stone materials, eliminating the need to transport heavy masonry or to apply stone veneers.
Precast Primer

Design Economy

D. Construction Efficiency, gained through precast concrete’s factory-controlled conditions, which can:

- ensure harsh winter weather does not impact the production schedule or product quality.
- allow components to be erected through the winter months, cut overhead costs, and provide quicker occupancy.
- maintain planned construction schedules with less need for “cushions” that make later scheduling more difficult.
- create tight tolerances that facilitate erection and minimize field adjustments.
- limit façade construction requirements to one trade, even for using or replicating brick, stone veneers or other aesthetic needs, eliminating the need for scheduling and budgeting additional subcontractors.

### Effect of Repetition on Panel Square-Foot Cost

<table>
<thead>
<tr>
<th>Number of reuses</th>
<th>Panel size (square feet)</th>
<th>Mold Cost</th>
<th>Cost per square foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200</td>
<td>$3,000</td>
<td>$15.00</td>
</tr>
<tr>
<td>10</td>
<td>200</td>
<td>$3,000</td>
<td>$1.50</td>
</tr>
<tr>
<td>20</td>
<td>200</td>
<td>$3,000</td>
<td>$0.75</td>
</tr>
<tr>
<td>30</td>
<td>200</td>
<td>$3,000</td>
<td>$0.50</td>
</tr>
</tbody>
</table>

Source: DN-11-02: Designer’s Notebook: Design Economy.

Note: This table reflects a typical cladding application of precast concrete architectural panels. The same or similar process can be used for a total-precast concrete structure.

### Effect of Panel Size on Erection Cost per Square Foot

(based on a minimum erection time of one month)

<table>
<thead>
<tr>
<th>Panel size (SF)</th>
<th>Erection Cost per Piece, $/square foot</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$500</td>
</tr>
<tr>
<td>50</td>
<td>10.00</td>
</tr>
<tr>
<td>100</td>
<td>5.00</td>
</tr>
<tr>
<td>150</td>
<td>3.33</td>
</tr>
<tr>
<td>200</td>
<td>2.50</td>
</tr>
<tr>
<td>250</td>
<td>2.00</td>
</tr>
<tr>
<td>300</td>
<td>1.66</td>
</tr>
</tbody>
</table>

Source: DN-11-02: Designer’s Notebook: Design Economy.

Note: Hypothetical erection costs only. Erection costs vary by project size and complexity.

Precast Budget Keys

- Economy of scale
- Use of thin-brick judiciously
- Flexibility in achieving aesthetic effects
- Take advantage of schedule benefits
- Involve precaster early in design
Precast Primer

Precast Resiliency

High Performance Precast Concrete’s resiliency expands on durability to include the ability to help restore the building to its full functional capacity with minimal efforts and resources after a major event such as an earthquake or hurricane. This also helps minimize negative effects to the environment after such an event, since resilient structures do not need to be completely rebuilt.

Protection from Natural Forces

Precast concrete designs can offer protection against such natural disasters as storms and floods, earthquakes, hurricanes, tornados and other high-wind situation. Considering these benefits early in the design process maximizes precast concrete’s effectiveness against each of these issues.

Storm resistance

A variety of precast concrete components can be used to create hurricane- and tornado-resistant structures, including foundation walls, load- or non-load-bearing precast concrete wall panels, and hollowcore plank for roofing and flooring.

Precast concrete also offers protection from wind-borne debris. Impact studies highlight this capability. During recent tests, lengths of 2x4 projectiles were fired at 100 mph toward various wall systems. The projectile penetrated the 2 x 4 stud and cavity wall systems with 3/4" OSB sheeting: one finished with vinyl siding, and the other with a 4" brick veneer. But the 2 x 4 projectile splintered when it impacted the precast concrete sandwich wall system.

With its high durability, precast concrete construction also resists surge damage. The use of precast concrete pilings can reduce the damage from water surging beneath a slab on grade.

Earthquake Resistance

Precast concrete can be designed to resist severe seismic events. New connection approaches, which have been approved or are in the process of being evaluated by code authorities, provide lateral resistance that meets building codes in earthquake-prone areas.

Precast components can span long distances between attachments to the main structure, even in seismic areas. Several of these concepts have been adopted into building codes such as ACI -318 which is referenced by the International Building Code. They include:

- a hybrid post-tensioned precast frame, codified in 1999, that withstands high lateral forces and allows a building to “self-right” itself after a seismic event.


- a pre-tensioned precast frame, Continuous, partially bonded pre-tensioned beams are connected to column segments. A moment connection is established between the beam and column through joint sleeves.

These options allow designers to meet any seismic challenge in any type of building nationwide. They can ensure that buildings not only remain safe during an earthquake but right its structure afterward, providing a safe haven and ena-
Precast Primer

Precast Resiliency

Resistance from Manmade Forces

Designers also need to protect against man-made forces, such as those caused by sprinkler activations, explosions, or fires. Planning and designing for these with High Performance Precast Concrete can ensure buildings are prepared for any situation.

Blast Resistance

Precast concrete components can aid designers in meeting protective Anti-Terrorist/Force Protection design requirements for government and high-profile buildings. This can be achieved in three ways:

- **architectural precast concrete** can be designed with sufficient durability to mitigate the effects of a bomb blast and satisfy General Services Administration and Department of Defense requirements.
- **structural precast concrete** can be designed with the proper connections and the necessary protection against progressive collapse.
- **protective barriers in decorative finishes** can be used at the building’s perimeter to limit and control vehicle access without disrupting neighborhood aesthetics.

Test results show that minimum required stand-off distances can be reduced when using precast concrete compared to traditional design requirements due to its inherent strength and resiliency.

Fire Resistance

Precast concrete does not combust, providing passive fire protection. Benefits accruing from this include:

- **easily achieving fire ratings** required by building codes with no additional post-construction treatments.
- **providing an inherent passive fire-protection system** that enhances other fire systems, such as sprinklers, which can fail.
- **slowing the spread of fire**, giving occupants more time to evacuate the premises and fire fighters more time to control the blaze.
- **protecting walls and roofing elements** during wildfires.
- **allowing reuse of wall panels** when the building is retrofitted.
- **withstanding structural failure** longer than other materials.
- **closing of joints** during fire exposure due to expansion when heated.

Better Indoor Environmental Quality

High Performance Precast Concrete enhances indoor air quality due to a variety of factors:

- Its **inorganic composition** does not provide food for mold spores, minimizing its ability grow.
- Its **fast erection** encloses buildings faster, providing a barrier between outside contaminants and moisture.
- Its capability to **leave interior faces exposed**, eliminating the need for drywall that can encourage mold growth.
Precast Primer

Risk Management

Precast concrete construction reduces professional liability for design professionals over cavity wall construction and other envelope systems that do not heavily involve the manufacturer in the detailing of the system and require a number of different products and subcontractors to construct.

Key Precast Risk Reduction Factors

Tier One Subcontractor

When utilized for both structure and envelope, precast systems comprise a high percentage of the total project scope. A contractor with a large percentage of work is considered a Tier One sub. Tier One subs reduce the coordination and communication burden for the architect.

Minimizing Number of Trades

Precast architectural wall panels can incorporate a variety of façade design elements, as well as continuous rigid insulation, without the detailing and coordination risk inherent in built-up facades utilizing a variety of products and requiring numerous subcontractors. The result is fewer RFIs and reduced change order risk for design professionals.

Design Assist Role

Precast producers offer design assistance service, and the industry recommends that architects contact them early in schematic design to allow them to assist in budget and schedule management. Precasters also provide specialized engineering and detailing assistance not offered by many structural engineers.

Reduced Coordination Issues

Fewer subs and integrated finishes in a single product result in a much lower coordination burden for the design professional—and reduced professional liability as well.

Production Standards

PCI Certification means a consistent standard of quality, backed by a national technical institute and inspection program that architects can rely on in specifying precast.

Schedule Conformance

Precast is the fastest building system available. Precast construction can save up to 40% in schedule time (and corresponding general conditions costs) over cast-in-place, masonry, and steel construction.

Budget Conformance

Early interaction with a precaster provides the architect with reliable cost and schedule estimates and assistance in producing the most economical design.

Minimizing Winter Costs

Precast erection is largely unaffected by cold temperatures or snow/ice, and does not require winter conditions procedures or change orders.

Performance Liability

Precast high performance wall panels provide scalable performance through adjustable continuous insulation with no thermal breaks, and the benefits of thermal mass in reducing peak loads and HVAC requirements.

Precast Multi-component Facades

Cavity wall appearance with less risk

- Typically 12’ wide x 30-40’ high
- 6000 psi concrete
- Can be load-bearing or non-load bearing
- Multiple colors and textures can be achieved in single panels
- High performance sandwich panels feature continuous insulation between two wythes of concrete
Precast Primer

Precast Innovations

As a fabricated material produced under closely controlled factory conditions, precast concrete provides the capability to adapt its composition and design to new techniques that arise. As a result, architects, engineers and precasters continue to push the boundaries of the material’s applications and design parameters.

New concepts in precast concrete continue to be introduced in an effort to continually improve the material to produce better looking, more economical and more efficient designs. Some of the current advances include:

Self-Consolidating Concrete (SCC)

SCC, also called self-consolidating concrete, features a concrete mixture that incorporates high-range water-reducing admixtures that significantly increase the material’s workability and fluidity. As a result, it flows quickly into place, fills every corner of a form and surrounds even densely packed reinforcement. Among its benefits are quality, aesthetic values, speed, design flexibility, and durability. SCC is most often used in long-line casting such as for double-tees, as well as pieces with dense reinforcing.

Ultra-High-Performance Concrete (UHPC)

UHPC consists of a steel fiber-reinforced, reactive-powder concrete that provides a compressive strength of 30,000 psi, more than twice that of any high-performance concrete used to date. It also includes steel or organic fibers measuring 1/2-inch long and six mills in diameter, which add tensile strength and toughness.

Carbon-Reinforced Precast Concrete

Produced under the name CarbonCast by Altus Group, a nationwide consortium of precast concrete companies, uses conventional steel for primary reinforcing and a resin-bonded, carbon-fiber grid for secondary reinforcing and shear transfer. The carbon-based product eliminates the potential for corrosion caused by secondary reinforcing. This in turn eliminates the excess concrete cover normally needed to protect steel from corrosion that results from exposure to moisture. CarbonCast is a proprietary product not available through all precasters.

Molded Concrete

Molded Concrete, in which ultra-high performance, fiber-reinforced concrete (UHPFRC) is molded into shapes to achieve specific attributes for projects. This concrete offers high compressive strength, (more than 22,000 psi) and flexural strength. The low weight and thinness allows the material to be cast for a wider range of applications. A high-quality finish can be achieved in a durable, quickly erected component.

Self-Cleaning Concrete

Proprietary technology (based on particles of titanium dioxide) is what makes this cement special. The technology can be applied to white or gray cement and it works like any other Portland cement. It is capable of breaking down smog or other pollution that has attached itself to the concrete substrate, in a process known as photocatalysis. As sunlight hits the surface, most organic and some inorganic pollutants are neutralized. They would otherwise lead to discolored concrete surfaces.

The titanium-based catalyst is not spent as it breaks down pollution, but continues to work. Typical products are oxygen, water, carbon dioxide, nitrate, and sulfate. Because rain washes away the pollution from the concrete surface, buildings stay cleaner and do not require chemical applications that are potentially harmful to the environment. Note: Titanium dioxide has recently been classified by the International Agency for Research on Cancer (IARC) as a Group 2B hazard, possibly carcinogenic to humans. The potential risks of this product are under study by the concrete industry.
Precast Primer

Specifying Precast Concrete

To ensure accredited certification is used on each project, the Precast/Prestressed Concrete Institute (PCI) recommends that specifying architects reference the following:

Manufacturer Qualifications: The specifying process should begin with a list of the required precast concrete products, from which the appropriate product group and category for each product can be determined based on the product’s use, the method of reinforcement and special surface finishes. PCI recommends manufacturer qualifications according to the following specification:

“The precast concrete manufacturing plant shall be certified under the PCI Certified Plant Program. The manufacturer shall be certified at the time of bidding. Certification shall be in the following product group(s) and category (ies):

Choose one or more of the following, as applicable:

GROUP A – ARCHITECTURAL PRODUCTS
AT – Architectural Trim Units
A1 – Architectural Precast Products

GROUP B OR BA – BRIDGE PRODUCTS
- B1 or B1A – Precast Bridge Products (No Prestressed Reinforcement)
- B2 or B2A – Prestressed Miscellaneous Bridge Products (Non-superstructure)
- B3 or B3A – Prestressed Straight-Strand Bridge Beams (Superstructure)
- B4 or B4A – Prestressed Deflected-Strand Bridge Beams (Superstructure)

[Group BA products require an architectural finish.]

GROUP C OR CA – COMMERCIAL (STRUCTURAL) PRODUCTS
- C1 or C1A – Precast Concrete Products (No Prestressed Reinforcement)
- C2 or C2A – Prestressed Hollow-Core and Repetitive Products
- C3 or C3A – Prestressed Straight-Strand Structural Members
- C4 or C4A – Prestressed Deflected-Strand Structural Members

[Group CA products require an architectural finish.]
Specify the type and quality of the materials incorporated into the units, the
design strength of the concrete, the mix and finishes and the tolerances for fab-
rication and erection. In the event of a performance specification appropriate
data should be included for the precaster to assess the scope and quality of the
precast units to be fabricated.

Specifiers should consider permitting variations in production, structural design,
materials, connection and erection techniques to accommodate varying plant
practices. Specifying the results desired without specifically defining manufac-
turing procedures will ensure the best competitive bidding. Required submittals
should also include range-bracketing samples for color and texture.

The specification section should include connection components embedded in
the precast concrete, related loose connection hardware, and any special devic-
es for lifting or erection, if required, as responsibilities of the precaster. Items to
be specified in other sections include building frame support provisions re-
quired to support units, including portions of connectors attached to the struc-
ture, joint sealing and final cleaning and protection.

### General Categories of Precast Specifications

**CATEGORY S1: Simple Structural Systems**

This includes horizontal decking members (such as hollowcore slabs on masonry walls), and single-lift wall panels
attached to a structure.

**CATEGORY S2: Complex Structural Systems**

This includes everything contained in S1 as well as total–precast concrete construction, multi-product structures
(those that combine vertical and horizontal members), and single- or multistory load-bearing members, including
those with architectural finishes.

**CATEGORY A: Architectural Systems**

This includes non-load-bearing cladding and GFRC products, which may be attached to a supporting structure.

PCI recommends manufacturer qualifications according to the following specification:

“Erector Qualification: Prior to beginning any work at the jobsite, the erecting organization, including all crews
erecting precast concrete, shall be certified in category[ies] [A, S1, and/or S2] under the Precast/Prestressed Con-
crete Institute (PCI) Erector Certification Program.”

For a complete guide specification for structural or architectural precast concrete, contact MAPA at
info@mapaprecast.org or 800 453 4447
Precast Primer

PCI Certification

Since 1967, PCI’s Plant Certification Program has ensured that each plant operated by a member has developed and documented an in-depth, in-house quality system based on time-tested national industry standards. PCI Certification is included in MasterSpec™, as well as a number of federal and military specifications.

Each plant undergoes two thorough, unannounced audits each year. The audits are conducted by independent accredited engineers, who inspect the company according to the types of products being manufactured.

PCI also certifies each plant’s quality-control personnel, through its Plant Quality Personnel Certification Program, which began in 1985. And it certifies erection procedures and field-quality control through its Field Qualification Program and Certified Erector Program.

A variety of benefits accrue to architects by using products fabricated at PCI-Certified plants. These include:

Cost

Certification does not increase the cost of using manufactured components. Most of the cost typically associated with subscribing to a certification program represents the cost of doing the job right.

Common Standards

Specifying products from certified fabricators ensures that a uniform yardstick of performance is being equally applied to all bidders. This reduces the temptation to cut corners, often in ways that are not readily apparent but can be significant to the finished project.

Reliable Project Partner

Certified fabricators make significant investments in plants, procedures, and people to meet certification standards. They develop a habit of measuring and achieving quality, and they offer a documented history of consistent production to meet specifications.

Faster Erection

Using quality products leads to more efficient field operations, which in turn prevents schedule delays. Quality control systems ensure components are properly identified and delivered in the appropriate number and order. It also ensures tight tolerances so they fit together quickly, cutting on-site labor and scheduling.

As-Designed Becomes As-Built

A designer’s vision, and his reputation for quality, depends on the capabilities of the fabricator and installer. Certification ensures the finished project meets the designer’s expectations and requires less supervision and field inspection, saving time and money.
Precast Primer

Resources

Online Resources

- Precast/Prestressed Concrete Institute (PCI): www.pci.org
- Mid-Atlantic Precast Association (MAPA): www.mapaprecast.org
- Concrete Joint Sustainability Initiative (CJSI): www.sustainableconcrete.org
- Portland Cement Association (PCA): www.cement.org
- American Concrete Institute (ACI): www.concrete.org

Architectural Design Resources

- Precast Primer: (available from MAPA)
- Architectural Precast Concrete manual (3rd edition): (available from MAPA in PDF version)
- Designer’s Notebooks: http://www.pci.org/Design_Resources/Guides_and_Manuals/Designer_s_Notebooks/
- CAD Details: www.mapaprecast.org
- Specifications: (available from MAPA)
- PCI Color & Texture Manual (available from PCI in print version or from MAPA in PDF version)

Engineering Resources


Contact MAPA:

info@mapaprecast.org
800 453 4447