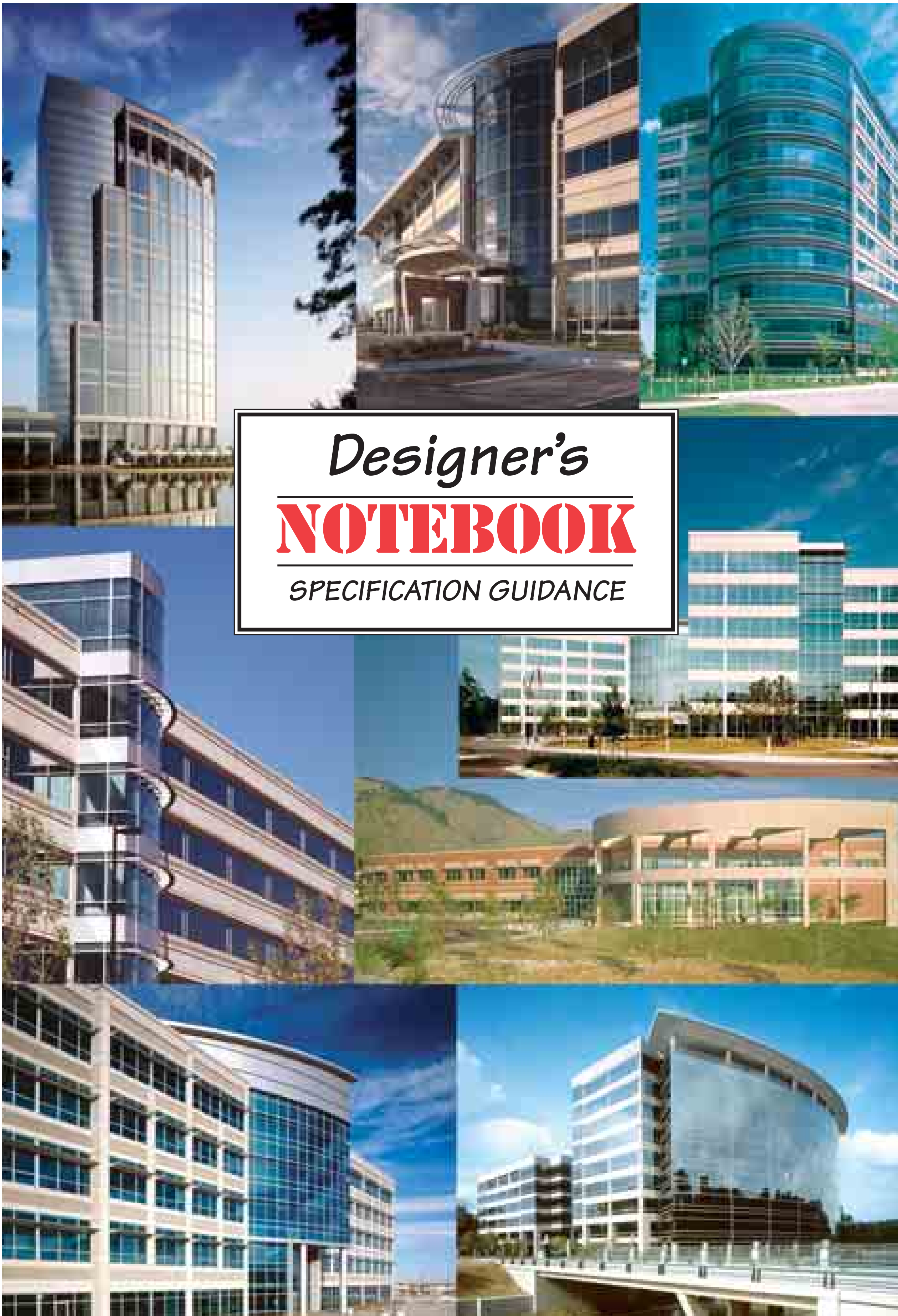
Designer's NOTEBOOK

SPECIFICATION GUIDANCE



PCI's Architectural Precast Concrete Services Committee explains key considerations in specifying architectural precast panels

Guide Specification for Architectural Precast Concrete Panels

THIS DOCUMENT

This document provides a basis for specifying in-plant fabrication including product design not shown on contract documents, and field erection of architectural precast concrete panels. It does not include precast structural concrete, nor does it include coatings applied to the panels or sealing the joints between panels.

Drawing and Specifications

Drawings:

The architect's or engineer's drawings should show panel locations and necessary sections and dimensions to define the size and shape of the architectural precast concrete panels, indicate location and size of reveals, bullnoses and joints (both functional and aesthetic) and illustrate details between panels and adjacent materials. When more than one type of panel material or finish is used, indicate the extent and location of each type on the drawings. The location and details of applied and embedded items should be shown on the drawings. Plans should clearly differentiate between this work and structural precast concrete if both are on the same job. Illustrate the details of corners of the structure and interfacing with other materials. Sizes and locations of reinforcement and details and locations of typical and special connection items and inserts may or may not be shown depending on local practices. If reinforcement and connections are not detailed, identify the requirements for design and design loads, and indicate load support points and space allowed for connections.

Specifications:

Describe the type and quality of the materials incorporated into the units, the design strength of the concrete, the finishes and the tolerances for fabrication and erection. It is important in the event of a performance specification that an appropriate test method be agreed upon as providing the basis of assessment.

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 manufacturing procedures will ensure the best competitive bidding. This may be done by stating structural and aesthetic results to be achieved and by requiring complete details in shop drawings. Required submittals should also include range-bracketing samples for color and texture.

The panel specification section should include connection components embedded in the precast concrete, related loose connection hardware and any special devices for lifting or erection, if required, as responsibilities of the panel manufacturer. Items to be specified in other sections include any building frame support provisions required to support panels, including portions of connectors attached to the structure, joint sealing and final cleaning and protection.

Coordination

The responsibility for supply of precast concrete support items to be placed on or in the structure in order to receive the architectural precast concrete units depends on the type of structure and varies with local practice. Clearly specify responsibility for supply and installation of hardware. If not supplied by the precast concrete fabricator, list supplier and requirements in related trade sections. (Note: When the building frame is structural steel, erection hardware is normally supplied and installed as part of the structural steel. When the building frame is cast-in-place concrete, hardware, if not pre-designed or shown on drawings, may be supplied by the precast concrete manufacturer or general contractor. Or it can be part of the miscellaneous steel subcontract, and placed by the general contractor according to a hardware layout prepared by the precast concrete supplier.)

The engineer of record needs to be aware of the magnitude and direction of all anticipated loads to be transferred to the building structural framing and their point of application. These loads should be addressed during pre-bid review, if possible. It is especially critical where outriggers and bracing may be necessary to resist torsion of the structural frame.

Assurance that type and quantity of hardware items required to be cast into precast concrete units for other trades, are specified is important. Specialty items, however, should be supplied in a timely manner by the trade requiring them. Verify that materials specified in the section on flashing are galvanically compatible with reglets or counterflashing receivers. Check that concrete coatings, adhesives and sealants specified in other sections are compatible with each other and with the form release agents or surfaces to which they are applied.

Several items mentioned in the Guide Specification as possible supply and/or installation by others should be mentioned in the specifications covering the specific trades. Such items may be:

- Cost of inspection by an independent testing laboratory.
- Hardware for interfacing with other trades (window, door, flashing and roofing items).
- Placing of contractor's hardware cast into or attached to the structure, including tolerances for such placing.
- Joint treatment for joints between precast concrete and other materials.
- Access to building and floors.
- Power supply.
- Cleaning.
- Water repellent coatings.
- Plant-installed facing materials such as natural stone and clay products.

Guide Specification In Development

A complete architectural precast Guide Specification is in development jointly by PCI, Gensler and the American Institute of Architects (AIA), Master Systems publishers of MASTERSPEC®.

Timothy Taylor, director of specifications with Gensler, shares his perspective on writing specifications for architectural precast concrete.

Match Architect's Samples: A specifier's dilemma

Thanks to PCI, a great body of information has been published on the advantages of architectural precast concrete, how to design it, how to engineer it and how to erect it. However, there is a paucity of print that guides a specifier through his or her task of converting what are esoteric or obscure architectural concepts into biddable specifications. This Designer's Notebook article is the first in a series that attempts to demystify the task of writing specifications for architectural precast concrete.

Specifications define product quality, product and system performance, workmanship and administrative procedures relative to a proposed architectural precast concrete construct. Because of the ever-increasing complexity of construction materials, standard's growth and variations in administrative procedures, it is impractical to include specifications as drawing notes for architectural precast concrete projects of any appreciable size. The drawings show size, form, quantity, relationship between materials and location of materials relative to the proposed construction. Both specifications and drawings are needed to describe a project. There should be no gaps between them nor should they overlap; the specifications and drawings should be complementary.

The process of architectural precast specification writing begins with understanding the scope of the contract documents to be created. Typically the designer's, and therefore the specifier's, responsibility extends to the selection, and documentation, of the esthetic and functional objectives for the architectural precast concrete design. In many cases, the components of these

"A single mix design, disciplined modularity, an intuitive understanding of the capabilities of precast, strong specifications, and effective communication between members of the construction team resulted in Gensler's successful two-phase 400,000-square-foot Discovery Square Office Building Project in Reston Virginia." Photo: Timothy Taylor

The deft use of modularity, textures, planes, reveals and a single mix design combined with precision craftsmanship in fabrication and erection can render cost effective three dimensional architecture in precast concrete as illustrated in this close-up image at Gensler's Discovery Square Project located in Reston, Virginia. Photo: Timothy Taylor

objectives may take weeks, if not months, to determine and to specify. When asked what is the single most important task in specifying architectural precast concrete Craig Taylor of Gensler's Houston office simply states "getting the right mix."

So what are esthetic and functional objectives? Esthetic specification objectives include the selection of the cladding material(s). Architectural precast concrete mixes, texture, and veneer cladding selections are made after considering the site context of the structure, glass and glass retention framing materials, limitations in available precast concrete materials and production capabilities, and the project schedule and budget. Esthetic objectives simply rendered as "match architect's sample" can lead to bid-period and post-bid-period misunderstandings. Flustered after several decades in the architectural precast cladding business and having to bid on poorly written specifications, a precast plant manager suggests that the specifier should "glue a piece of sandpaper of the desired color and texture into the spec and have the precaster match it."

What data needs to be specified? The answer comes from a fundamental understanding of project-specific requirements and some of the basics of architectural precast panel manufacture.

Architectural precast concrete is predominantly composed of cements, coarse aggregates, natural and manufactured sands, and sometimes pigments. Color, and consequently color tone, represent relative values. They are not absolute and constant but are affected by light, shadow, density, time and other surrounding or nearby light reflecting colored surfaces. A concrete surface, for instance, with deep exposed opaque white quartz appears slightly gray. Shadows between the particles blend with the actual color of the aggregate and produce this graying effect. These shadows in turn affect the color tone of the matrix. Color tone will change as the sun traverses the sky. A clear sky or one that is overcast will make a difference as will landscaping and time. A low water/cement ratio cement paste is always darker than a high water/cement ratio paste made with the same cement.

Cement used in architectural precast concrete is available in gray or white. Each possesses inherent color and shading differences depending on its brand, type, mill, and quarry source. For example, some gray cements are nearly white while others have bluish, reddish, or greenish tones. Some white cements have a buff or cream undertone, while others may have a blue or green. Gray cement is less expensive than white cement; however, white cement provides a wider range of possible color combinations than does gray cement. White cements also are easier to patch. A finely ground gray or white cement is normally lighter in color than a coarse ground cement of the same composition. Gray cements are generally subject to greater color variation than white cements even when supplied from one source. If gray shades are desired and optimum uniformity is essential, a mixture of gray and white cement is often chosen.

Landscaping, obscured glass, light, shade, shadow and attention to detailing at glass and horizontal rib terminations add interest and crisp clean lines to an ordinary parking garage screen wall at Discovery Square. Photo: Timothy Taylor

Large amounts of carbon dioxide are generated in the manufacture of Portland cement, which many claim contributes to global warming. Seeking to reduce these emissions and garner sustainability credentials, some designers may consider fly ash or silica fume as partial substitutes for Portland-cement content in precast. These substitutes are the byproducts of power generation and manufacturing processes. Their use will benefit the environment, achieve higher strength and lower permeability; however they will slow concrete strength gain, may affect color tone if light tones are desired, and in the case of silica fume, require more mix water. According to Terry Collins of the Portland Cement Association, these materials do not have enough calcium hydroxide to completely substitute for Portland cement's role in concrete. As such, there are limitations on their proportion to Portland cement, which are published by American Concrete Institute and PCI. Many architectural precasters may object to the additional cycle time required for the precast strength to develop before they strip formwork. This may be the major reason that many precasters have not embraced the use of these materials in their production.

Most precasters want to know primarily what the coarse aggregates are to be. They have a number of good reasons. Their first concern is whether or not they will need to ship aggregates from remote quarries. Long-distance hauling, by truck or train, may have a large impact on the final panel cost. Aggregate type and size will play a major role in controlling unit water requirements, proportion of water to sand, cement content and workability. Grading variations and excessive fines can affect batch-to-batch color uniformity. Some aggregates may lack the necessary physical properties to withstand the desired finish texturing. Aggregates possessing high compressive strengths are recommended where high-pressure sandblast or ground-finish textures are required. Some aggregates may not be suitable for acid-washed finish textures as they could discolor or dissolve. Natural gravels may dislodge and shatter when exposed to bushhammer texturing. Glass and ceramics are aggregates that can be used to achieve architectural effects or sustainability goals. If these types of aggregates are being considered, they should be examined for reactivity with proposed cement alkalis and for their ability to remain in place (bonded to the cement) after proposed finish textures are applied.

Fine aggregates (sands) also play a role in the color and texture of precast concrete. This is especially true where coarse aggregates are not intended to be exposed, such as for retarded, acid-washed or brush-blast textured finishes. A case in point would be where simulated white or buff limestone is desired. In these applications, color uniformity is critical. Therefore, gradation and source controls, either from a pit or quarry or by stockpiling, for the entire project, must be provided by the precaster. Compounding the color uniformity issue is the fact that many natural sand sources lack the necessary whiteness that is demanded to create light-colored simulated limestone. In order to compensate for lack of sources some precasters will proportion more costly manufactured local or imported sands to adjust for desired color tones.

The use of selected cements, coarse and fine aggregates predominates in the production of architectural precast panel manufacture. Occasionally, however, desired precast color tone cannot be achieved with available cements and aggregates without the use of pigments. Pigments can be manufactured from a multitude of materials, provide many shades of color, and have varying degrees of color retention. Just a small amount is perceptible to the human eye, especially when they are incorporated into pure white cement and sand mixes. Exercise prudence when pigments must be specified. Pigments in liquid form have provided better dispersion results over dry-mixed pigments. Automated processes with liquid color and batch-sized factory packaging of dry-mixed pigments have reduced the occurence of color non-uniformity within a single panel and make panel-to-panel color uniformity easier to achieve. Large amounts may reduce concrete strength. Long-term color retention may not be possible with certain pigments. If pigments must be used, obtain and evaluate testing results, not certifications, of their color-retention characteristics, and visit projects where pigments were used by the proposed precaster.

A single mix design, combined with automated batching of a liquid-dispersed pigment system, stringent attention to batching and material quality controls, and three degrees of paste removal produced these uniformly colored and textured precast panels in Tyson's Corner, Virginia.
Photo: Timothy Taylor

—Timothy Taylor, Director of Specifications Gensler, Washington, D.C.

To be continued in the Winter 2003 issue.