



Precast/Prestressed Concrete Institute

# Successful Planning with Architectural Samples

PCI's Architectural Precast Concrete Committee offers tips and suggestions on achieving the proper color, form, and texture on any project



# designer's notebook

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The proper selection of color, form, and texture for a building's architectural precast concrete exterior is critical to creating a successful aesthetic appearance. Different colors and textures can be achieved by varying and combining aggregate, matrix color, finishing processes, and depth of exposure. A combination of two or more types of finish or textures can be created within the same panel, providing a wide variety and flexibility in selecting the final appearance (Fig. 1). Knowing how to use samples and what sizes or mockups are required can ensure the project's success.

Early on, develop a schedule for creating samples and determining uniformity of colors and texture requirements. Although material and production factors may cause differences in color or texture, uniformity variations on the facade will be minimized if the sample development procedures that are detailed in this article are followed. The precaster can provide significant input in selecting the textures and finishes to achieve the desired aesthetic effect and ensure that design concepts translate into reality.



Figure 1 Appearance variations are achieved with different finishes on the same concrete mixture. (Courtesy: Architectural Precast Concrete)

The building's appearance results from the architect's use of light, shadow, color, form, and texture. Color and, consequently, color tone represent relative values. They are affected by light, shadow, density, time, and nearby colors. Thus, color selection should be made in lighting that replicates the light and shadows of the site's natural daylight.

Some color and texture differences between nominally identical precast concrete units are inevitable, but variations between and within panels should be kept within an agreed-upon range. Therefore, at the sample development stage it is important to reconcile the expectations of the owner and architect with the practical limits of uniformity.

The sample development process includes the following:

- creating prebid design reference samples to establish the general color and texture for the project
- producing approval samples after the contract award to evaluate the same mixture under typical production conditions
- producing range sample panels that are about 15 ft<sup>2</sup> to 20 ft<sup>2</sup> to show the anticipated range of color and texture
- viewing initial production panels or mockups to see the final outcome of the process based on bulk ordering of currently quarried materials and full concrete batches

## Development of Samples

Achieving the desired textures and colors through feasible production techniques is a process that requires the precaster to produce samples that satisfy the architect's design concepts. This can be accomplished by producing a few samples, or it may require a series of samples and considerable investigation of corresponding production and finishing techniques.

At this stage of the procedure, the development of samples may involve considerable expense in research and investigation on the part of the precaster. Most precasters will assist the architect in developing a design reference sample as early as possible. The architect can aid in sample development by visiting precasting plants that have sample selections on hand to assist in setting limits for the desired finish. Alternatively, for the initial selection of color, texture, and finish, the Color & Texture Guide at [www.pci.org/publications/ctg/index.cfm](http://www.pci.org/publications/ctg/index.cfm) can serve as a visual reference (**Fig. 2**).

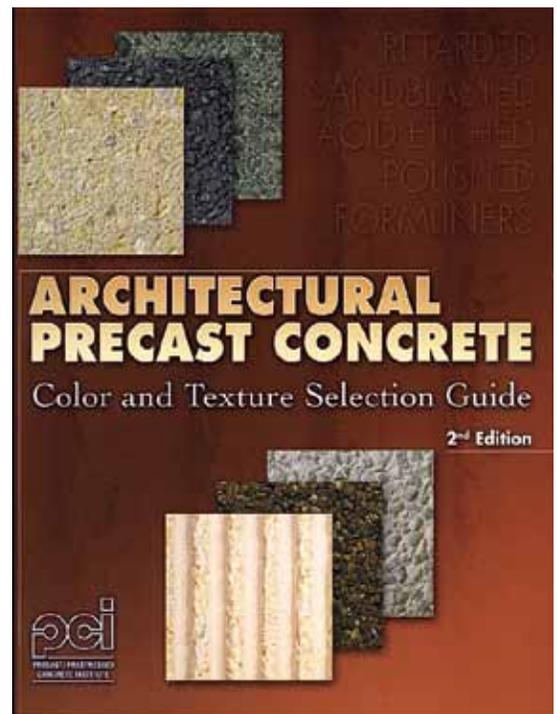


Figure 2

Because different precasters utilize different material sources and manufacturing techniques, the photographic samples in the guide and the final product will not be an exact match. Samples must be made to ensure that the desired colors and textures are matched satisfactorily. Samples for architectural precast concrete are custom produced to translate the architect's specific design concept into a standard for realistic and economic production requirements.

Because the architect is responsible for the final decision, design judgment should be supplemented with an assessment of the operating procedures and technical personnel from all plants likely to bid on the project. Watching plant operations and talking with plant personnel also help the architect obtain an understanding of production considerations.

## Prebid Samples

Once a project's sample for each color and texture has been finalized, the designer should make the samples available to all interested precast concrete bidders to view and photograph. In some cases, multiple samples are made so that each precast concrete bidder can have a sample. Listing the mixture proportions for the selected samples in the specification is encouraged so that all bidders have identical information.

It is recommended that all precasters approved for a particular project develop samples for approval as a prerequisite for bidding. If the precast concrete units have an exposed interior finish, such as a trowel finish, samples of the finish, color, and texture should also be shown for the back surface.



**Figure 3** Samples show color, finish, and texture at the precasting plant. (Courtesy Paul Grigonis)

Samples should be at least 12 in. square with a 2 in. thickness to provide information on mixture proportions (color tone) and finishes (texture) for the architect's initial aesthetic evaluation (**Fig. 3**). Larger samples are recommended, but they may be difficult to handle.

Product appearance is influenced by factors such as form, complexity of the casting, and physical mass, as well as the natural characteristics of the concrete ingredients. In short, a single 12 in. × 12 in. sample may not accurately represent a production casting. Larger samples—the next step in the process—are necessary to give a true picture of the possible finish variations over a large area, to demonstrate normal surface blemishes, to incorporate rustication details, or to show the effects of the natural day-to-day variations of aggregates and cement.

The design reference samples are for initial verification of design intent relative to color and texture and should be regarded only as a standard for performance within the variations of workmanship and materials to be expected.

Individual plant preferences, differences in sources of supply, and different techniques developed by various plants serving the same area mean that not all precasters will be able to obtain an exact match of the selected samples. Many architects select and approve samples prior to bid closing. Then the approved precasters' names and corresponding sample code numbers are published in an addendum or the approval list is given in writing to the general contractor.

This practice may result in slight variations in color, aggregate, or texture but not necessarily in the quality supplied by different bidders. The individual precaster, within specification limits, selects the materials and employs the placing and finishing techniques best suited to its plant operations. By making approval of prebid samples a prerequisite for bidding, the architect and client are protected by requiring equivalent optimum quality from all precasters. Then those involved know the result to be achieved in color and texture of the finish. The following requirements should be adhered to by any architect making prebid sample approval part of the specifications:

- Sufficient time, usually about two weeks, must be allowed for the bidder to submit samples or information for approval. Time also must be provided to allow the approvals to be conveyed to the precaster in writing so that the precaster can estimate and submit an accurate bid.
- If the mixture proportions for the selected samples are not available, any prebid submittal should be treated in confidence by the architect and general contractor/construction manager and the individual precaster's solutions and/or techniques should be protected both before and after bidding.

If the characteristics of submitted prebid samples deviate from the project specifications, the precaster must make this clear when submitting the samples and other required information for approval. For proper evaluation and approval of the samples, the precaster should state the reasons for any deviations. These reasons might include the precaster's concern over controlling variation in either color or texture within specified limits.

The architect should request data to evaluate the deviations. If the deviations and samples are approved, the architect should change the original project specifications and contract drawings to match the new samples.

## Production Approval Samples

After award of the contract but before producing any units, the precaster prepares and submits for approval a representative sample or samples of the required color and texture.

For nonplanar, curved, or other complex shapes, a flat-cast sample may not represent the anticipated appearance of the final product. Sample shapes should be selected to offer a reasonable comparison to the precast concrete units they represent. Also, the sizes of the samples should reflect the relationship among materials (for example, the maximum size of the aggregate to be used), finishes, shapes, and casting techniques. These techniques include mold or formliner types, the thickness of the concrete section, the orientation of exposed surfaces during casting, and consolidation procedures. If the precast concrete units have an exposed interior finish, such as a finish ready for painting, samples of the back-surface workmanship, color, and texture should be shown as well.

Also, architects should specify that the matrix's color or tone match that of the coarse aggregate so that minor segregation of the aggregate won't be noticeable. Panels containing aggregates and matrices of contrasting colors will appear less uniform. As the size of the coarse aggregate decreases, less matrix is seen and the panel's color will appear more uniform. Once the small samples are within an acceptable range, larger samples should be made to confirm that the mixture proportions, vibration, and finishing techniques necessary to make production-sized pieces could duplicate the aesthetic qualities of the small sample pieces.

**Figures 4** shows that a 12 in. square sample with a 2 in. thickness may bear little relationship to the appearance and physical characteristics of a production panel. Differences in mass, density, and curing rate between the sample and the production panel may make direct comparison difficult. This is particularly true for insulated sandwich panels.

Full-scale and quarter- or half-scale samples (usually 4 ft × 4 ft) can be used to evaluate the production methods and the finished products. The panels should incorporate details of architectural features, finishes, textures, and transitions from one color or texture to another. For example, if return elements are to be cast with a major panel section, the samples should have returns cast with them to represent the way that the finish will be accomplished on such sections. The production of uniform, blemish-free samples that demonstrate the abilities of a single master craftsman will be misleading and could cause endless difficulties when the production personnel using actual manufacturing facilities have to match the sample.

## Range Samples

Range samples should be produced based on the plant's past experience with a mixture or finish and for large projects with multiple approving entities with little apparent precast concrete experience. At least three range samples of one size (full scale but not necessarily full sized) should be produced to demonstrate actual planned production conditions. These should establish the anticipated maximum and minimum ranges of acceptance as well as the optimum target for color and texture variations; uniformity of returns; frequency, size, and uniformity of air-void distribution; surface blemishes; and overall appearance. The approved range samples or mockup panels should be stored outdoors and positioned to allow comparison of finished production units with the acceptable range samples. They should be stored adjacent to each other to ensure similar lighting (sun and shade) for daily comparisons of finish and exposure with production units. There is no reason to expect the finished product to vary significantly from the range samples.

**Figure 5** shows the acceptable range of concrete samples made with  $\frac{3}{8}$  in. aggregate with retarded (left side) and acid-etched (right side) finishes. Only two of the retarded finishes were within the acceptable range on the three approved acid-etched samples. Therefore, one additional sample was made to obtain an acceptable range for the retarded finishes. **Figure 6** shows the production panel made after the samples were accepted.

The acceptability of repair techniques for chips, spalls, or other surface blemishes can also be established on the production approval, range samples, or mockup units. The face of each sample should contain at least two areas of approved size and shape that have been chipped out and then patched and repaired. The color, texture, and appearance of patched areas should match those of the adjacent surface. Repairs should be at least one month old before acceptability is judged. Perfecting a repair procedure can save both time and money in the final outcome of the project.



**Figure 4** Panels assist in finish selection.

*(Courtesy Architectural Precast Concrete)*



**Figure 5** These range samples show retarded finishes on the left and acid-etched finishes on the right.

(Courtesy Architectural Precast Concrete)

## Mockups for Production Approval

If the project's size warrants, the architect and owner should authorize the expenditure for mockups, either of a partial or full-scale portion of a panel or an entire typical unit. The mockups usually encompass most of the different shapes and finishes on typical panels (**Fig. 7**). Investing in such mockups removes uncertainties held by both the architect and owner about the overall appearance of the completed building and verifies conformity to established design guidelines. Larger samples require considerable time to produce, and they should not be specified unless sufficient lead time exists.

In some cases, after the design reference samples are selected, a precaster may be engaged to fabricate a mockup with all ancillary materials. Then all precasters would use this as a basis for their bids. This approach eliminates production-schedule delays. Also, it may be desirable to separate the mockup costs from the base bid so that the cost can be evaluated separately.

Aesthetic mockups can offer the opportunity to evaluate the fit and finish of all of the exterior materials as well as the following specific precast concrete factors:

- details on the exposed face and uniformity of returns
- erection and bracing techniques
- connection details
- colors and finishes of adjacent materials (for example, window frames, glass, and sealants)
- dimensional accuracy of the precast concrete work and the constructability of the specified tolerances
- acceptability of the precast concrete unit's inside surface finish (where exposed)
- suitability of the selected sealers, if specified
- weathering patterns or rain runoff on a typical section of the precast concrete facade

Mockups should be produced using standard production equipment and techniques. Important variables that should be controlled as close to actual casting conditions include the retarder coverage rate and method of application, if used; mixture proportions and slump; admixtures; the temperature of fresh and cured concrete; vibration; piece thickness; the age at which finishing operations are performed; and the method of cleaning. This is especially important with light etches that are particularly affected by changing conditions. Special details, such as reveal patterns and intersections, corner joinery, drip sections, patterns, colors, and textures should be demonstrated in the mockup units for approval. Changes in aggregate orientation, color tone, and texture can easily be noted on full-scale mockup panels.

The mockups allow the precaster and designer to explore a series of options for particularly challenging details prior to full-scale production. The mockup sample can demonstrate the more-detailed conditions that may be encountered in the project, such as recesses, reveals, outside/inside corners, multiple finishes, textures, and veneers. Mockup panels should contain any expected cast-in inserts, reinforcement, and plates. Designers can inspect window interfaces, joints and sealants, connections, and other critical elements to ensure that they are visually acceptable and will properly interface between trades.



**Figure 6** This production panel was made after the samples were accepted. (Courtesy Architectural Precast Concrete)



When the mockups are manufactured and erected, all interested parties should be present and ready to discuss the approval for panel production. If surface texture or other changes are desired, all information should be recorded. Depending on the changes, production should not begin until the changes have been made and the mockups are approved.

During range-sample or mockup review, the precaster will ask the architect or representative to inspect and approve (sign and date) the range-sample panels or mockup. These then supersede the previously approved 12 in. x 12 in. samples.

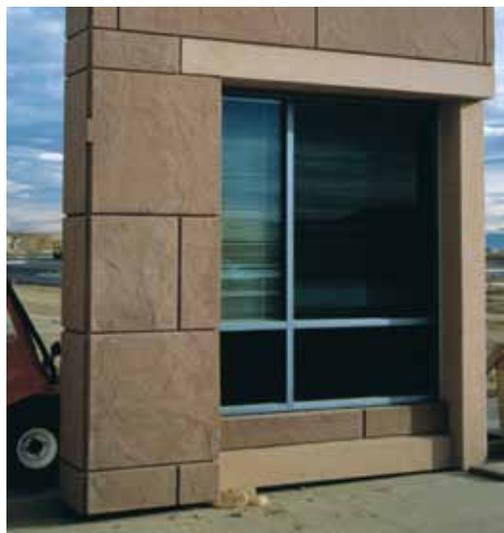


## Visit the Precaster

Where mockups are not used, it is recommended that the architect or owner visit the precast concrete plant and approve (sign and date) the initial production units. This approval should precede a release for production to avoid potential controversies later. However, delays in visiting plants will upset normal operations and the job schedule. The contract documents should state clearly how long the production units or the mockup structure will be kept in the plant or at the jobsite for comparison purposes.

The contract documents also should permit the approved full-scale mockup units to be used in the job installation in the late stages of construction. The units should remain identifiable, even on the structure, until final project acceptance. The panels should be erected adjacent to each other to allow continued comparison if necessary.

Designers can exert more control over the final appearance using precast concrete thanks to finish and range samples as well as mockup panels. By visiting the precaster to monitor progress, the architect and owner can help ensure no surprises arise at the site.



## Assessment of Samples and Finished Product

When assessing 12-in.-square samples, most people will try to visualize how the entire unit, or even the entire facade, will look. This unrealistic view may lead to disappointments when production begins and remedies become expensive or impossible. If 12-in.-square samples are used to select the aggregate color, the architect must remember that the general appearance of large areas of a build-

**Figure 7** Mockups usually show the different shapes and finishes on typical panels.

(Courtesy Architectural Precast Concrete)

ing wall tend to be lighter than the samples. Also, panels will appear darker when damp than when dry.

Determining acceptable uniformity of color, finish, and texture is by visual examination and is generally subjective. However, suitable criteria for product acceptability require that the finished concrete surfaces should have no readily visible imperfections other than minimal color and texture variations from the approved samples. Also, the surface should not show evidence of repairs when viewed in typical daylight illumination with the unaided eye at a 20 ft or greater viewing distance. Appearance of the surface should not be evaluated when light is illuminating the surface from an extreme angle because this tends to accentuate minor surface irregularities due to shadowing.

Mockups are assessed most effectively when mounted in their final orientation. Samples viewed from a distance of a few feet will reveal details that will not be noticed on a building when viewed from 50 ft to 100 ft. Details should be appraised from a distance typical for the distance of the installed panel. Overlooking this may lead to demands for shapes, textures, and drafts that are not only expensive but may not even be identifiable in the finished building. Approved 12 in. × 12 in. samples should also be compared to the mockup to ensure that the original intent has not been lost.

Both designers and owners should realize that the selection of a 12 in. × 12 in. architectural precast concrete sample represents only the first step in the development of the actual production of that element. It should not be considered a final decision. When you are completing the approval process of larger samples, mockups or approval of the first production panels is extremely important and develops communication among all parties regarding acceptance criteria and ensures that design concepts translate into reality. 



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