Precast/Prestressed Concrete Institute

Design Economy

PCI's Architectural Precast Concrete Services Committee offers insight on the architectural precast manufacturing process to help achieve design goals and control costs

designer'snotebook

Design Economy —Article XII

PCI's Architectural Precast Concrete Services Committee offers insight on the architectural precast manufacturing process to help achieve design goals and control costs

Understanding architectural precast costs is essential to designing elaborate façades that enhance the overall building design while meeting the owner's budget. Understanding the architectural precast manufacturing process can help achieve design goals and control costs. Many variables need to be considered to determine what a typical architectural precast project will cost. All engineering, production, delivery and installation costs must be compiled for each specific project to derive an applicable budget price.

During a project's conceptual stage, the designer has many items to consider. These include material selection, textures, surface geometry, cross section, unit repetition and erection methods. The custom, sculptured designs that are possible with precast concrete may be achieved within a limited budget by selecting economical aggregates and textures combined with repetitive units and effective production and erection details. A local precast manufacturer can assist with preliminary design and budget estimating early in the project's design phase.

Las Olas Centre is a mixed-use project in Fort Lauderdale, Fla., that includes two recently completed high-rise towers. Built adjacent to one another, the buildings include ground-level retail, parking and office space on the upper floors. The parking floors are set back from the retail arcade, and an auto court is defined by flanking domed towers between the two buildings.

Architectural precast concrete was selected to replicate the look of Florida limestone on the classically styled buildings. Produced with a mix of local limestone aggregate and white cement with buff coloring, the lightly sandblasted precast panels feature deep reveals and recessed medallions at the intersections of various reveals and joints. (Courtesy *Kevin Cantley, Cooper Carry*)

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During a project's preliminary design, a precast project can be budget "guesstimated" on a square-foot basis. Although this provides a good starting point, it is not recommended that designers rely on this method alone for several reasons:

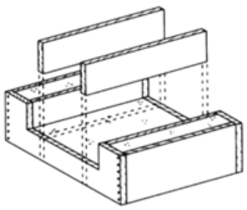
1. A project's square-foot quantity take-off can differ between precast manufacturers, general contractors and architects, depending on the take-off procedures used.
2. Square-foot prices are rough, educated guesses based on incomplete information.
3. Work-scope criteria (specifications, etc.) typically are non-existent in a project's early stages.
4. Erection access and crane requirements are not defined early in a project.
5. The necessity of back forming and other detail manufacturing requirements cannot be predicted accurately in the early design stage.

Following the devastation of Hurricane Andrew in 1992, South Florida building codes became more stringent. This resulted in a window-wall system that was more rigid than had been typical for such projects. Supplied by the window-wall manufacturer, an extruded-aluminum channel into which the glass curtain wall locks was cast into the top and bottom of the precast spandrel beams. This rigid connection allows a more positive transfer of load back. The window-wall system was designed to resist wind loads of 132 to 157 pounds per square foot and a 1,200-pound impact load from windborn projectiles. (Courtesy *Kevin Cantley, Cooper Carry*)

Working with a local precast manufacturer on the specifics will help determine a final budget that is more accurate. A lump-sum budget price from the local precast manufacturer, submitted in writing (including assumptions), will minimize surprises on bid day. As a project evolves from preliminary sketches through working drawings, the budgeting precasters should be informed of all changes to ensure the budget prices remain valid.

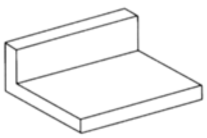
Pricing accuracy depends on the information provided to the precaster's estimator. This article uses both lump-sum and square-foot prices to describe a designer's precast options. All prices are for relative comparison only and should not be used to make "concrete" decisions for your individual project.

The key factors in designing economically with architectural precast are the repetitiveness of pieces, average piece size and erection efficiency.

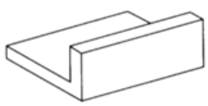


Surface of panel
is trowelled flat

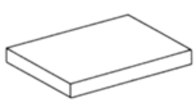
Timber mold



Panel with
left hand return



Panel with
right hand return



Intermediate panel

Repetition

A key element to cost-effective production is to minimize the number of molds and mold changes and to maximize the number of castings from each mold, particularly if the molds have shape. Efficiency is achieved by making it possible for similar, if not identical, shapes to be produced from the same basic (master) mold and by minimizing the time required to disassemble a mold and reassemble it for the manufacture of the next piece.

Regardless of the material used, molds can be expensive to construct. An individual mold's complexity determines its cost. Simple reveals and rustications typically are considered a standard mold cost. Reveals and rustications must be placed in a repetitive pattern to minimize modification throughout a mold's life. Reveals, like all form features, must be designed with a small draft (by creating bevels) so the panel can be stripped from the form without damaging the form feature.

Adding more intricate features introduces cost premiums to a project. Only your local precast manufacturer can calculate these mold-cost premiums. Projecting cornices, bull noses, form liners, bottom and/or top returns and curves are the most typical features to be added. The exact size, shape and locations are the designer's options. However, repetition must be considered when applying these design features. Considerable cost will be added if the location of these features within a mold will be changed frequently.

On the other hand, these intricate features can be added at a minimal overall cost if they are used repetitively in the overall design. The point behind designing repetitive pieces is to amortize engineering and mold costs effectively. As many pieces as possible should be designed to be cast in the same mold and produced from a single shop drawing. The practical goal should be to yield 20 to 30 pieces from each mold.

Mold Costs

Mold costs can range from hundreds of dollars to thousands of dollars per mold. The cost difference depends on mold size, complexity and materials used. The mold material selected typically depends on a project's schedule. A project with a long lead time should permit fewer molds to be built, but it also may require more expensive, longer-lasting molds.

Wood and fiberglass molds will last for about 20 to 30 castings before they must be completely refurbished or replaced. Knowing that a precast manufacturer will construct a form for about every 25 pieces, a designer can plan on creating a different shape for 25 pieces without increasing the project's mold cost.

A master mold can include numerous design elements such as bullnoses, cornice details, reveal patterns or window openings. However, once in place, the design elements should be

The North Pavilion at Duke University Medical Center in Durham, N.C., used architectural precast concrete as its exterior building material. The North Pavilion serves as the main entrance for the University's Medical Center campus. As such, Cooper Carry desired a crafted look that fit the project's economical requirements, and architectural precast concrete accomplished this goal.

The building's limestone-colored precast is a retarded, exposed aggregate finish on the ground level, which provides a human-scaled base for the building, and a sandblasted finish on the upper floors. The base was extended to enclose a courtyard with a precast arcade between the North Pavilion and the existing parking garage. The precast mix of the existing parking garage was the basis for the mix design of the North Pavilion. The building's mix was modified with the addition of small black stones, giving a shine to the North Pavilion's appearance.

The building has both straight and curved façades that were easily shaped and detailed with architectural precast concrete panels. The façade includes bullnose bands, sequentially cast returns and deep reveals to provide the scale and detail suggestive of masonry or stone. The result is a beautifully sculpted gateway building for Duke University Medical Center. (Courtesy *Kevin Cantley, Cooper Carry*)

consistent (repetitive) from piece to piece. But it is important to remember that individual castings do not have to be the same size, color or texture.

Also, a master mold can be slightly modified throughout the production cycle to give the designer maximum flexibility. This strategy eliminates the need (and cost) of constructing a mold for every panel change.

It is relatively easy to alter a mold if the variations can be contained within the total mold envelope by use of bulkheads or blockouts rather than by cutting into the mold surface. When a large number of precast concrete units can be produced from a single mold, the cost per square foot will be more economical, as shown in **Table 1**.

A large number of panels can be produced from a single mold, built to accommodate the largest piece, and then subdivided as needed to produce the other required sizes. Although every project will have atypical conditions, the more cost-effective projects maximize the repetition of elements. The more often a mold is re-used, the lower the cost of the piece and thus the total project.

The premium cost for complex shapes can be controlled by adding details to specific forms only, as shown in **Table 2**. Examples include designing a cornice at parapet panels, a sill detail at intermediate floors or one elevation as a radius.

Other Forming Considerations

Optimum production economy is attained if the panel can be separated from the mold without disassembling the mold. This is done by providing draft or slope on the sides of all openings and perimeter sides. Designers are urged to consult the local precasters for specific draft recommendations.

All architectural precast panels are produced face down to give the maximum aggregate consolidation at the panel surface and to achieve the smoothest finish. Two-sided precast pieces (front and back) requiring identical appearances should be avoided .

The most expensive forming technique is back forming. Back forming is used to create returns that give the appearance of thick, massive panels that add significant shadow features to the façade. These returns also can allow windows to be set back away from the building's face from 6 inches to a few feet. To achieve these shapes, special forms must be constructed and then suspended over the primary mold to create the desired panel depth.

Number of Reuses	Panel Size (sq. ft.)	Mold Cost	Cost per Sq. Ft.
1	200	$3,000	$15.00
10	200	$3,000	$1.50
20	200	$3,000	$0.75
30	200	$3,000	$0.50

Table 1 Effect of repetition on panel per sq. ft. cost.

A second common production method to make returns is a two-part pour. The return piece is produced on Production Day 1. On Day 2, the return piece is removed from its form and is connected to a master mold. The return is cast monolithically to the master piece. Two-part pours are preferred over the method described above because they create a more uniform texture on all sides of the panel.

Pieces	Project Total Sq. Ft.	Forms Affected	Project Premium	Premium per Sq. Ft.
100	12,500	1	$4,000	$0.32
100	12,500	2	$8,000	$0.64
100	12,500	3	$12,000	$0.96
100	12,500	4	$16,000	$1.28

Table 2 Project price changes based on the number of forms affected by the complex shape.

The required number of molds of a given type for a project often is determined by the time allowed for completing the job. In many cases, this time factor to meet the project's schedule is what creates the demand for duplicate molds, trumping the desire for mold economy. The necessity for extra molds increases costs and partially offsets the intent of designing for high repetition. The designer should discuss realistic precast engineering and production lead times for the project with a precast manufacturer.

It is vital to include precast-scheduling information with the bid documents. This will ensure all bidders understand the project time frames required. Ample lead time also will allow the manufacture of larger pieces first, followed by smaller ones, thus minimizing the cost of form repairs.

Panel Size

Precast pricing is determined primarily by the size of the pieces and piece repetition. Also, precast pricing is more dependent upon large pieces than upon a large project. For example, a 100-piece project of large panels can be less expensive per square foot than a 1,000-piece project of much smaller panels.

Burdines Department Store is known throughout the Sunshine state as "The Florida Store." Federated Department Stores, parent company of Burdines, asked Cooper Carry to update the exterior design of its new stores to more closely reflect the customer's upscale image.

The new design focused on Burdines' icon, the palm tree. Playing on this highly recognizable icon, Cooper Carry integrated the palm tree into key areas of the exterior design in the new Burdines Aventura and Orlando, Florida, stores. Curved architectural precast concrete panels were embossed with a palm-leaf pattern, while illuminated acrylic renditions of the palm icon were positioned behind glass display windows to draw customers to the entrances.

White precast panels, supported at the foundation, are made from a mix of white marble and granite chips to provide sparkle and contrast with the deep blue Florida sky. The level of quality, detail, color and texture required for these projects could only be accomplished through the use of architectural precast concrete. (Courtesy *Kevin Cantley, Cooper Carry*)

The Lazarus Department Store in downtown Pittsburgh, Pa., was designed to complement its urban surroundings and the city's rich architectural history. Precast concrete panels are a very economical way to cover broad areas, and architectural precast concrete is a durable material that will weather well. The use of architectural precast concrete and glass created a distinctive, urban look which is associated with traditional downtown retailing. (Courtesy *Kevin Cantley, Cooper Carry*)

The reason piece size is so important is because most every labor function performed by an architectural precaster and erector is required because of the existence of a piece. The more pieces the project has, the more labor hours it will take to engineer, cast, strip, finish, load, deliver and install the panels. Therefore, it is more economical to cover a larger portion of the building's exterior with fewer precast panels.

Therefore, for economy, it is best to make precast units as large as possible within normal manufacturing and shipping limitations. Handling/erection of precast components constitutes a significant portion of the total precast expense. The cost difference in handling and erecting a large unit versus a small unit is insignificant compared to the increased square footage of a large unit, see **Table 3**. To be economical a project's average piece size should be at least 100 to 125 square feet and ideally larger than that.

Table 4 gives examples of how, even though a panel's lump sum price increases, as the panel size increases, the square-foot price decreases rapidly. One method of lowering a project's square-foot price is to add square footage without adding pieces.

Panel Size (sq. ft.)	Erection Cost per Piece ($/sq. ft.)			
	$300	$600	$900	$1,800**
50	6.00	12.00	18.00	36.00
100	3.00	6.00	9.00	18.00
150	2.00	4.00	6.00	12.00
200	1.50	3.00	4.50	9.00
250	1.20	2.40	3.60	7.20
300	1.00	2.00	3.00	6.00

* Based on a minimum one month of erection time.
** New York City.

Table 3 Effect of panel size on erection cost per sq. ft.*

Sq. Ft. per Piece	Cost per Piece	Cost per Sq. Ft.
100	$3,000	$30.00
150	$3,500	$23.22
200	$4,000	$20.00

Table 4 Lump sum price versus piece size.

There is no exact optimum size. Usually the optimum panel size is dictated by size and weight limitations imposed by transport and site cranage capacity. To determine the optimum size of architectural panels, a close collaboration between the designer and a local precaster is required during the early stages of building design. The designer should be familiar with highway legal load limitations, or ask a local precaster. Piece sizes that require highway permits for over height, width, length or weight generally should be avoided. The common tractor/trailer payload in many areas is 20 to 22 tons with a product size restriction of 8 ft. in width, 8 ft. in height, and 45 ft. in length. If a unit will fit within these confines, it can be hauled on a standard flatbed trailer without requiring permits. By use of lowboy or drop deck (step deck) trailers, the height can generally be increased to about 10- to 12-ft. without incurring special permit load costs. Panels up to 15' 8" can be transported only on specially built tilt frame trailers but with certain restrictions. However, the shorter bed length of lowboys, drop decks or special trailers may restrict the length of the piece. Most precasters do not have a large fleet of these special trailers, so it is necessary to consult a local precaster to determine what sizes are economically feasible.

For a particular project, designing larger panels, even though they may carry a hauling premium, may be most cost efficient. For example, an office building with 30- by 30-foot column spacing requires fewer columns, fewer precast panels and yields a more wide open interior than the same building with 20- or 25-foot column spacing. The cost premium (if any) to haul two 30-foot long panels versus three 20-foot long panels usually can be more than overcome by cost savings in other engineering, production and installation. The typical parking structure may have 60-foot plus perimeter panels that run parallel with the 60-foot long double tee floor system. The double tees can not carry the perimeter panel weight alone. A structural beam would have to be added to support a 60-foot long perimeter panel. Therefore, the added cost to haul a 60-foot long panel is overcome by the beam's omission.

In addition to providing cost savings during erection, larger panels provide secondary benefits by shortening a project's schedule, reducing the amount of sealant needed, and requiring fewer connections. Thus, large units are preferable unless they create significant cost premiums for transporting and erecting.

If a design requires the appearance of smaller units, the inclusion of false joints (rustications or reveals) cast into the face of larger elements can give the illusion of smaller elements. These false joints can be caulked to increase the illusion of small panels.

Material and Labor Costs and Uniformity of Appearance

Panel manufacturing costs (materials plus labor) are other major factors in finished precast unit costs. Material factors and labor processes that cost more but at the same time increase visual uniformity are shown in **Figure 1**. (Assumptions and general comments for this figure are shown in **Table 5**.) This data is based on the cost structure of a typical Midwest plant. Good product color and textural uniformity at moderate cost can be obtained by the designer by selecting an optimum combination of items shown in **Figure 1**.

It is difficult to provide extremely accurate cost figures for different precast surface finishes, since individual plants may price them somewhat differently. Some plants, for instance, consider acid-etched surfaces an expensive finish. Some precasters discourage its use, while others may prefer its use to sandblasted or retarded (exposed aggregate) finishes.

For reasons of appearance and cost, aggregate choice is an important factor. Aggregate cost is determined primarily by the distance of the quarry to the manufacturing plant. Most aggregates cost the same to remove from the earth and to crush to the appropriate size. The trucking cost from the quarry to the plant is the principal cost variable. In order to minimize mix cost, a designer should discuss aesthetic requirements with a local precaster. Ask the precaster for aggregate color options and their associated cost. The lump-sum cost should be presented on the basis of both per-cubic-yard and per-square-foot.

A particular aggregate's cost should be calculated only for the amount of face mix used. If a gray back-up mix is used, do not calculate this material cost for pricing comparisons. Most precast panels are produced with ½, thickness of face mix (usually 2 to 3 inches) and ½ back mix. Panels with large projections and returns will increase the face mix quantity required. Window setbacks may dictate the thickness of the face mix. As the set back increases so does the amount of the more costly face mix. If the panel configuration is such that little or no back-up concrete can be used, then the cost of the facing aggregate can have a significant effect on the cost of the panel.

Precasters can modify mix ingredients depending on the selected finish in order to lower material costs. For example, some acid-etched finishes will expose only the coarse aggregate

	Assumptions	Comments
General	1. Panel size = 150 sq. ft.	Costs will generally decrease as panel sizes increase. The most cost effective panels are generally larger than 100 to 125 sq. ft.
	2. Panel thickness = 6" w/ 3" of face mix	Flat panels w/o recessed windows can use less face mix. Panels w/recessed windows, shape, or returns require more face mix.
	3. Form repetition = 25 times	Form costs must be amortized over the number of castings that are made within the form. Always attempt to use the "master mold" concept.
	4. Includes labor, overhead, and profit	
Cement Content		Gray cement is sold for structural applications. The cement manufacturers do not attempt to control the color of gray cements. They do actively try to control white cement color and brightness. Gray and white cements can easily be blended to achieve reasonable uniformity at lower cost. Uniformity normally increases as the percentage of white cement increases.
Aggregates		More expensive and less expensive aggregates sometimes are blended to reduce costs.
Pigment Dosage		Lower dosages of pigments often are used to create subtle shades, but very low dosages will not yield good color consistency. High dosages are used to create strong colors. Often white cement must also be used to increase pigment effectiveness and thus color consistency.
Form Surface	1. Liner covers the entire form surface	1. Often partial bands of liner are used to create texture differences within a panel. This is generally less expensive than covering the entire form surface. Remember that liner is a manufactured product and often has size and module limitations that must be considered during design.
	2. Bullnose/cornice assumes a projection of 12"–18" with some steel forming of the shape	2. Smaller, less complex projections will greatly reduce the cost.
Surface Finish		1. Acid-etched surfaces should normally be created by using a white cement base for color uniformity. 2. Because of the fine, flat surface resulting from an acid-etched finish, the panel surface should be broken up with details or rustications to break up the surface mass. Doing so will result in a more uniform color appearance.
Mix/Finish Complexity		Details must be provided at mix/finish changes in order to provide a termination line for a mix/finish change.

Table 5 Factors related to cost & perceived color uniformity: assumptions and comments.

tips. Thus, expensive coarse aggregates can be minimized or eliminated since they will not be seen. Since sandblasting dulls the coarse aggregates, less expensive aggregates may be used. Local, less expensive aggregates may look very close to expensive aggregates after they are sandblasted. A bushhammered finish will give a similar appearance to sandblasting without dulling the aggregates. Exposed aggregate or retarded finishes expose the coarse aggregate to reveal their natural beauty. So these mixes require colorful coarse aggregates and thus tend to be more expensive.

By incorporating demarcation features, multiple mixes can be incorporated in a single panel. A designer can also achieve different colors and textures from a single precast mix simply by varying the finish treatment. This multiple-finish technique offers an economical yet effective way to heighten aesthetic interest.

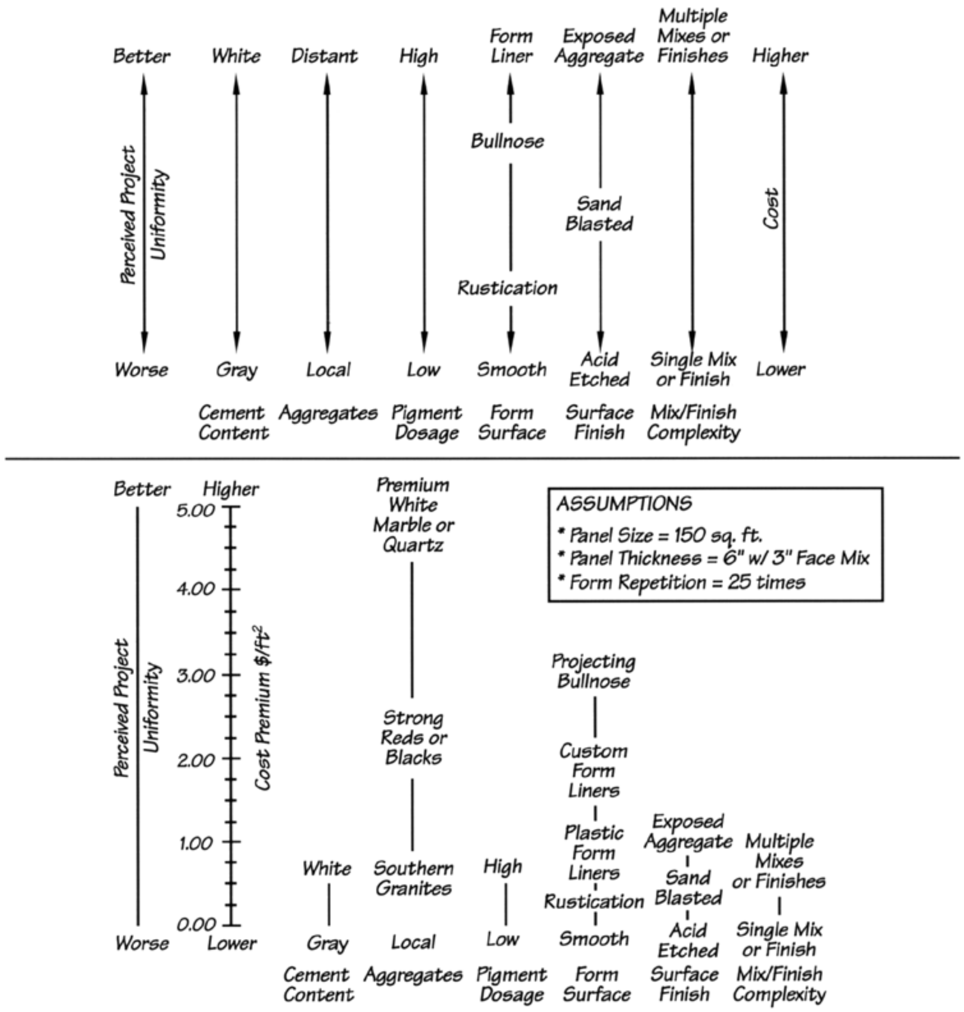


Figure 1 Factors related to cost and perceived project uniformity.

It is desirable to develop the mix design before the project goes out for final pricing. Most precast manufacturers are eager to assist the architect in developing a control sample as early as possible. The best method in selecting a sample is to visit the precast plant to view a multitude of samples and finished panels stored in the yard . Alternatively, a designer can refer the precaster to an existing example and give them a piece of natural stone (or other material) to match.

It is common for a designer to create a new, one of a kind concrete mix. When visiting a plant, the designer can select the cement color, aggregate type and size, and surface finish method/depth. Asking a precaster to make several different samples is common and is encouraged. Once a project's 12- by 12-inch sample for each color and texture has been finalized, the designer should make the sample available to all interested precasters to view and photograph. In some cases, multiple samples are made so that each precaster can have a sample. Listing the exact mix ingredients in the specification is not necessary.

The new Douglas County Courthouse in Douglasville, Ga., unified the county's administrative and judicial spaces in a single facility for the first time in the county's 127-year history. A monumental project for the community, the client desired a dignified facility with rich materials and architectural details at the pedestrian level to give the building a more elegant character.

Accomplished through traditional architecture, the design incorporates architectural precast concrete with true classical proportioning systems such as columns, cornices, and pediments. The detailing of fine architectural features and forming of unusual shapes were accomplished through the use of architectural precast concrete. Tapered, fluted columns create a feature focal point at the main entrance, a 40-foot diameter rotunda that separates and unifies the administrative offices and court facilities. (Courtesy *Kevin Cantley, Cooper Carry*)

The cost of reinforcement is typically not significant in architectural precast concrete. An exception is the choice of finish of the connection hardware and reinforcement. The cost of galvanized or epoxy-coated reinforcement is substantial, and is not normally required. Additionally, it is not a substitute for adequate concrete cover or concrete quality. Connection hardware cost is governed mainly by structural load requirements, including special structural functions and possible earthquake considerations. Hardware cost may be minimized by making the precast concrete units as large as is consistent with the size limitations discussed earlier in this article. Four lateral and two gravity connections are the minimum required for most precast concrete units regardless of size. The labor cost of producing and handling small individual pieces of hardware normally exceeds the material costs, thus increasing the relative cost of hardware for small units.

Design Options

Design options are literally endless. Employing these options intelligently adds a great deal of design interest to a project with only minimial cost increases. The following design strategies can cost from pennies per square foot to a few dollars per square foot.

1. Incorporate multiple colors throughout a building façade.
    a. Panels can contain more than one concrete face mix.
    b. Panels can be produced with multiple finishes. The combination of finish methods will determine the cost impact.
2. Add a special shape to one distinct building area.
    a. Design an appendage to an existing form. Doing so will cost less than adding a full form, yet will provide a nice building detail.
    b. Set windows back from the building's face at one or two column bays or at certain levels.
    c. Add a few small ornate pieces at the entrance or as site walls. The small panels will be more expensive per square foot, but a few of them amortized over the entire project will add a minimal additional charge ($15,000 increase/30,000 square feet = $.50 premium),
3. Apply a partial facing material to the precast at the plant. Brick, tile, terra cotta or natural stone accents can be added in limited number at minimal cost.
4. On steel-frame structures, gravity and lateral support brackets (for precast connections) should be in the structural steel fabricator's scope of work and should be shop-welded to the structural-steel columns rather than field-welded. It is much less expensive to shop-fabricate and shop-weld them than to hoist and field-weld heavy support brackets.

In most cases, design interest can be enhanced without increasing price by using more complex precast in one area and offsetting the cost premium by economizing in another area. For example, trade some details for more repetition. Eliminate small column covers at one level and place more ornate ones at the entrance.

Architectural Precast Economies Versus Other Materials

Architectural precast offers many cost advantages over other cladding materials. Precast is produced all year round in a controlled, cost-efficient production environment. In addition, precast can be installed year round even in harsh winter conditions. This eliminates the need for costly winter weather protection and contributes significantly to compressing the overall building schedule.

Architectural precast can enclose the project quicker than any other cladding material. Typically, more than 1,000 square feet can be installed each day (10 pieces per day at 100 square foot each). Precast's installation speed can shave months from a construction schedule, thus reducing construction financing cost.

Precast spandrel panels commonly are used as a vehicle-impact restraint in parking structures in addition to providing a perimeter design feature. Doing so eliminates the need for an upturned cast-in-place concrete beam or a cable system.

Coca-Cola Parking Structure, Atlanta, Ga.

Cooper Carry has recently completed two parking facilities in Atlanta, using architectural precast concrete as the primary building material. The Coca-Cola Parking Facility, an 825-car, five-story deck located at the company's headquarter complex, is constructed of precast concrete panels on a cast-in-place concrete structure. The SunTrust Parking Deck, a 750-car, eight-level parking facility located on an urban site, used architectural precast panels, textured-coated concrete and brick. (Courtesy *Kevin Cantley, Cooper Carry*)

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Located in Lawrenceville, Ga., the new corporate headquarters for Scientific Atlanta is a campus development of four office buildings oriented around a centrally located entry pavilion. Each office building is four levels and 150,000 square feet and is interconnected by enclosed bridge structures. The campus also includes two parking decks that accommodate 2,200 cars.

The headquarters development, completed in two phases over a three-year time frame, is designed with smooth and retarded finish architectural precast concrete and low-E insulating vision glass. The efficient, rectangular design of the office buildings allowed spans of 30-foot precast concrete panels to be used, which was an economical design solution. The circular form of the entry pavilion was formed with architectural precast to provide a contrasting element that identifies the entrance to the campus and complements the design of the office buildings. Alternating precast finishes provided a clean architectural vocabulary that is aesthetically pleasing in its natural environment.

During the early stages of design, precast was recognized as providing durability, ease of maintenance and a cost-effective solution to the building skin. (Courtesy *Kevin Cantley, Cooper Carry*)

Architectural precast panels can span great distances (20 to 60 feet) and be connected directly or adjacent to structural columns. This advantage allows the designer to control the gravity loads to reduce the structural-framing costs.

Precast can be stacked onto a foundation. This way all precast gravity loads of a multistory building can be transferred vertically through each panel and ultimately onto the foundation. Where this design is used, the structural-steel frame resists precast's wind loads only, permitting the frame steel to be lighter and less expensive. This design must allow for building drift.

In high-rise construction, vertical precast panels can span multiple floors. Multiple vertical floor spans of precast panels require gravity loads to be supported at only one floor per panel (every two or three floors.) That way, the majority of the floors can be designed without the need to support the gravity loads of the exterior skin, reducing the overall structure's cost. This approach may not be practical in high seismic zones due to drift requirements.

Routinely, precast panels provide support for gravity and wind loads of other material, such as windows, curtain walls, storefronts and sometimes even brick. This capability reduces the framing cost of these adjacent cladding materials and reduces structure costs. More expensive traditional materials can be replaced with cost-efficient architectural precast. Precast can be colored and textured to mimic natural stone (granite, marble, limestone, sandstone or slate). Or, these materials can be cast integrally into the exterior face of precast panels. This latter fabrication method reduces the contractor's financial risk by assigning the stone responsibility to the precast manufacturer. In addition, time-consuming and costly on-site stone installation costs are completely eliminated.

More and more, brick-faced precast panels are being substituted for field-laid masonry for many reasons: cost savings, brick material shortages, qualified mason shortages, owner's schedule requirements and winter construction.

Summary

Early in the design phase, the designer should evaluate all the factors influencing the economics of a particular architectural precast concrete project. To arrive at an optimized solution, the designer will need to seek early consultation with a local precaster. The precaster should be challenged to suggest options for creating a good economical design that also satisfies the designer's aesthetic requirements.

If possible, the designer should visit manufacturing plants, as well as projects under construction. This way the designer can become familiar with the manufacturing and installation processes. Such tasks as mold fabrication, challenges to casting and finishing specific designs or shapes, relative material costs, handling methods at the plant and jobsite, and approaches for connecting panels to a structure are important to fully understand in order to optimize the cost of the precast concrete.

— Kevin Cantley, President and CEO, Cooper Carry Atlanta, Ga.

Cooper Carry served as the architect in the design-build delivery approach to provide a new operations center for the State Farm Insurance Companies. The four- story, 135,000-square-foot center is located on nine acres in John's Creek Technology Park, which contains primarily low-rise, brick buildings in Duluth, Ga. Completed on a fast-track schedule, the project used architectural precast concrete panels because the panels could be manufactured while the structural frame was under construction. As soon as the structural frame was complete, large components of the exterior precast concrete skin were put in place, ready to receive the window framing system. (Courtesy *Kevin Cantley, Cooper Carry*)

designer's notebook

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