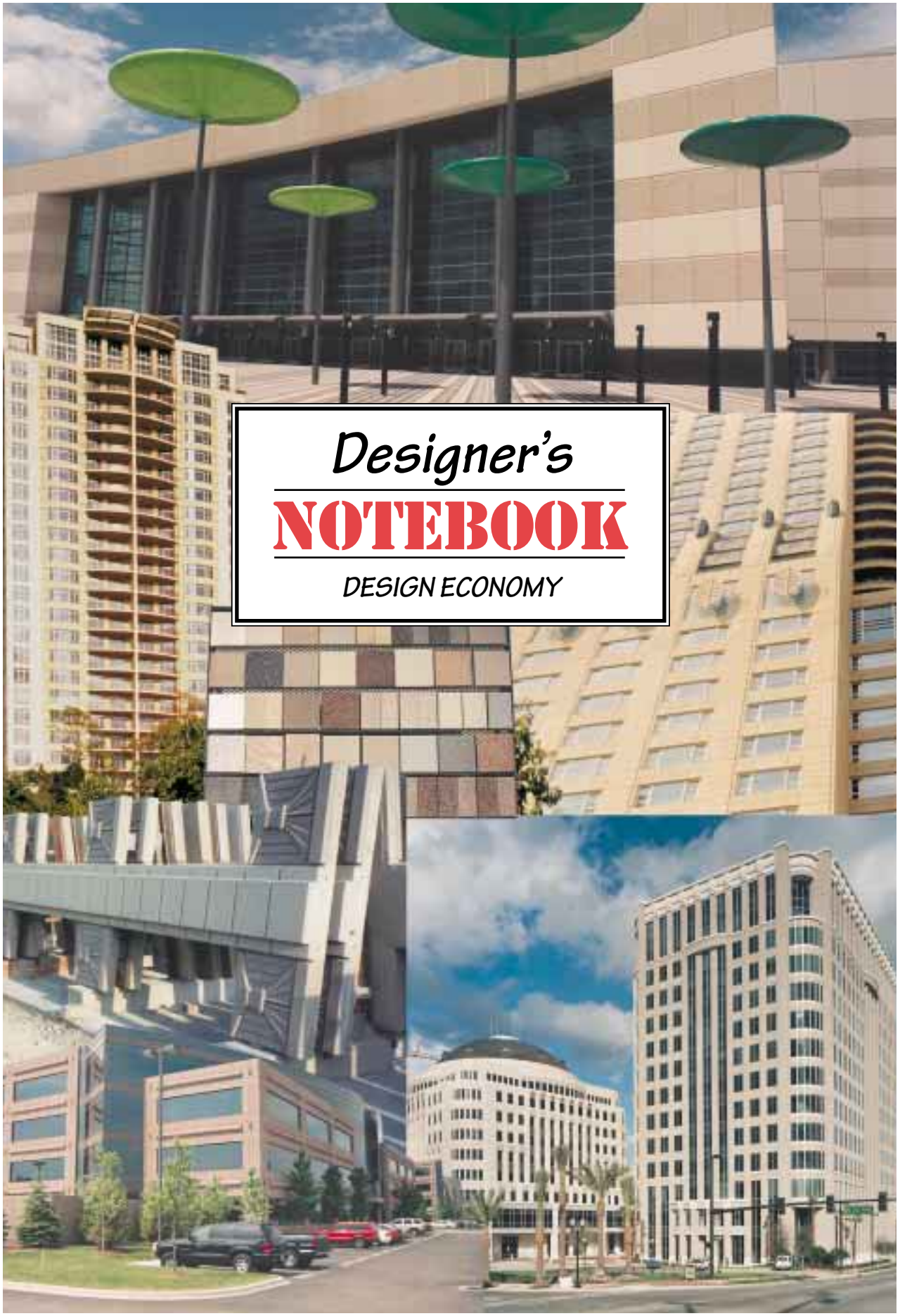


Designer's NOTEBOOK

DESIGN ECONOMY

Design Economy – Article XII (Part 1)

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

With architectural perspective by Kevin Cantley, President and CEO, Cooper Carry

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, Fort Lauderdale, Fla.

Las Olas Centre is a mixed-used 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. — Kevin Cantley, Cooper Carry

Las Olas Centre, Fort Lauderdale, Fla.

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 wind-born projectiles. — Kevin Cantley, Cooper Carry

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.

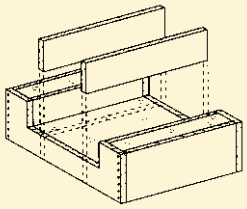
Working with a local precast manufacturer on the specifics will help determine a final budget that is more accurate. A lump-sum budget price from the local precast manufacturer, submitted in writing (including assumptions), will minimize surprises on bid day. As a project evolves from preliminary sketches 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.

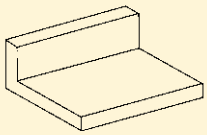
Repetition

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.



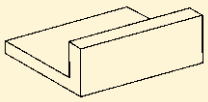
Timber mold

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.



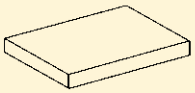
Panel with left hand return

Adding more intricate features introduces cost premiums to a project. Only your local precast manufacturer can calculate these mold-cost premiums. Projecting cornices, bullnoses, 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.



Panel with right hand return

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.



Intermediate panel

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 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.

North Pavilion at Duke University, Medical Center, Durham, N.C.

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.
— Kevin Cantley, Cooper Carry

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**.

TABLE 1. Effect of Repetition on Panel Sq. Ft. Cost

Number of Reuses	Panel Size (Sq. ft.)	Mold Cost	Cost per sq. ft.
1	200	$3000	$15.00
10	200	$3000	$1.50
20	200	$3000	$0.75
30	200	$3000	$0.50

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.

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

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

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.

Burdines Department Store, Orlando, Fla.

Burdines Department Store is know 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. — Kevin Cantley, Cooper Carry

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.

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.

- Next: Part 2 of Design Economy