

Clay Product-Faced Precast Offers Beauty, Economy — Article IX

PCI's Architectural Precast Concrete Services Committee highlights the advantages of working with clay product-faced precast panels

Clay product-faced precast concrete is being used increasingly today to beautify building exteriors. It gives the architect the flexibility to combine the pleasing visual appearance of traditional clay products with the strength, versatility and economy of precast concrete.

Among the types of materials that can be bonded directly to precast concrete are brick, ceramic tile and architectural terra cotta. These clay product facings may cover the entire exposed panel surface or only part of the concrete face, creating accents. This combination of precast concrete and clay products offers several important benefits over site laid-up masonry.

A Palette of Styles

Architectural precast concrete claddings offer a palette of styles, allowing the designer's imagination to soar through the range of possibilities from reproduction of past styles of to the creation of new patterns for buildings of the future. This freedom of aesthetic expression could not economically be accommodated with site laid-up masonry.

Precasting techniques allow complex and intricate details such as arches, radii, ornate corbels and numerous bonding patterns to be incorporated into the finished panel. This prefabricating approach ensures that high-priced and time-consuming building skills are transferred to the controlled conditions of the plant and away from the critical path of on-site activities. Doing so keeps alive the great range of visual design possibilities that otherwise might be stifled by economic constraints.

Precasting also allows a high level of dimensional precision and quality control. Concrete mixes and mortar batching, together with curing conditions, can be tightly controlled, whereas site-laid masonry will have highly variable curing and mortar quality.

Plant production provides for year-round work under controlled temperature conditions, negating any on-site delays due to inclement weather. In addition, precast panels can be produced while foundation work progresses and can be erected directly from delivery trucks in most any weather. This allows the structure to be enclosed earlier, with finishing trades able to complete their work much sooner.

Clay-product clad precast also eliminates the need for costly on-site scaffolding and greatly reduces the masonry cladding time duration.

Panel configurations include a multitude of shapes and sizes: flat panels, C-shaped spandrels, soffits, arches and U-shaped column covers. (See Fig. 1.) Repetitive use of any particular shape also lowers costs dramatically. Returns on spandrels or column covers also are possible. Panels may serve only as cladding or may be loadbearing, supporting floor and roof loads.



Fig. 1: Radial brick was cast into radiused precast concrete panels for the S.C. Johnson Worldwide Professional Headquarters in Mt. Pleasant, Wis., to create the smooth flow around corners. Architects: Zimmerman Design Group and Hellmuth, Obata & Kassabaum Inc.

Design Considerations

To develop maximum bond to the concrete, the best backside surface of clay-product units is a keyback or dovetail configuration. Grooved- or ribbed-back units also will provide adequate

<p>Bowing Considerations</p>	<p>bond. With thin-clay products, no metal ties are required to attach them to the concrete since adequate bond is achieved. In general, clay products that are cast integrally with the concrete have bond strengths exceeding that obtained when laying units in the conventional manner (clay product to mortar).</p> <p>The bond between the facing and the concrete depends on the absorption of the clay product and the concrete's water-cement ratio. Either low or high absorption will result in a poor bond. Bricks with water absorption of 6 to 9 percent obtained by 5-hour boiling provide good bonding potential.</p> <p>Unglazed quarry tile and frost-resistant glazed wall tiles generally don't need to be wetted. Terra-cotta units should be soaked in water for at least one hour prior to placement to reduce suction, and they should be damp at the time of concrete placement.</p> <p>Because of the differences in material properties between the facing and concrete, clay product-faced concrete panels are more susceptible to bowing than homogeneous concrete units. However, panel manufacturers have developed design and production procedures to minimize bowing.</p> <p>Minimum thickness of backup concrete of flat panels to control bowing is usually 5 to 6 inches, but 4 inches can be used where the panel is small or where it has adequate rigidity obtained through panel shape.</p> <p>Prestressing of panels has been used on many projects and has been effective in controlling bowing of long, flat, relatively thin panels. Prestressed panels which are 8 inches thick have been produced up to 60 feet in length, with a maximum sweep (bowing) of 1/2 inch. It is recommended that, in non-prestressed concrete panels, a control joint be introduced through the clay product face thickness when the panel length exceeds 25 feet.</p>
<p>Panel Sizes</p>	<p>The overall size and weight of the panels basically are limited only to what can be handled conveniently and economically by available transportation and erection equipment. Generally, panels span between columns and usually are spaced 20 to 30 feet on center, although spandrel panels have been as large as 8 by 60 feet.</p> <p>The height and length of the panels should be multiples of nominal individual masonry unit heights and lengths. The actual specified dimensions may be less than the required nominal dimensions by the thickness of one mortar joint but not by more than 1/2 inch. For economical production, the precaster should be able to use uniform and even coursing without cutting any units vertically or horizontally except as necessary for running bond patterns.</p>
<p>Appearance Considerations</p>	<p>The appearance of clay product-faced precast concrete panels is achieved principally by the selected clay product, with type, size and texture contributing to overall color.</p>

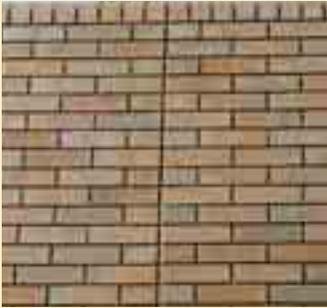


Fig. 2: Brick patterns must be continuous through adjacent panels.

Also, the degree to which the clay product units are emphasized will depend upon the profile and color of the joint between units.

Due to forming requirements, it is preferable that joints between clay products be not less than 3/8 inch wide. A 1/4-inch joint may be used satisfactorily when the joint faces are smooth and well defined, as in a wall of flush-pointed, smooth-faced clay products, such as tile.

The joints between panels are usually butt joints. A quirk miter joint is used sometimes with the thin-brick thickness being the quirk dimension.

Both stack and running bond patterns have been used widely in precast concrete panels. With running bond, it is less costly and visually much more appealing if courses start and finish with half or full bricks. (See Fig. 2.) This approach avoids cutting and allows for matching adjacent spandrels or column covers. Vertical alignment of joints, especially with stack bond, requires close clay product material tolerances.

Variations in brick or tile color will occur. The clay-product supplier must preblend any color variations and provide units that fall within the color range selected by the architect. Defects such as chips, spalls, face score lines and cracks are common with brick, and the defective units should be culled from the bulk of acceptable units by the supplier or precaster according to the architect's requirements and in accordance with ASTM specifications. Should minor damage occur to the clay product face during shipping, handling or erection, field remedial work can be accomplished easily, including replacement of individual clay products. Units may be chipped out and new units installed using an epoxy, dry-set or latex-portland cement mortar.

Selecting A Clay Product

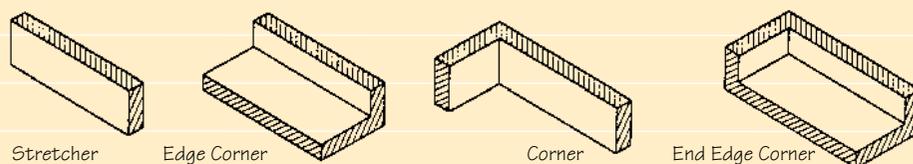
Clay-product manufacturers or distributors, along with the precaster, should be consulted early in the design stage to determine available colors, textures, shapes, sizes and size deviations, as well as manufacturing capability for special shapes, sizes and tolerances.

In addition to standard facing brick shapes and sizes (conforming to ASTM C216, Type FBX), thin-brick veneer units 3/8 to 3/4 inch thick are available in various sizes, colors and textures. Thin-brick units 1 inch thick with smooth backside surfaces also may be available. Thin brick should be a minimum of 1/2 inch thick to ensure proper location and secure fit in the template during casting operations and to minimize the tilting of individual units. The thin bricks must conform to ASTM C1088 Type TBX.

Brick Sizes

Stretcher, corner or three-sided corner units are typically available in a variety of color ranges. (See Fig. 3.) The face sizes normally are the same as conventional brick and therefore,

Fig. 3: Thin brick units.



when in place, give the appearance of a conventional brick masonry wall.

The most common brick face size is the standard modular, with nominal dimensions of 2-3/8 inches by 8 inches. The actual face dimensions vary slightly among manufacturers, but they are typically 3/8 to 1/2 inch less than the nominal dimensions. An economy or jumbo size is 50 percent longer and higher.

Table 1:
Nominal modular
face sizes of brick.

Unit Designation	Face Dimensions	
	Height (inches)	Length (inches)
Standard	2-2/3	8
Engineer	3-1/5	8
Economy 8 or jumbo closure	4	8
Norman	2-2/3	12
Norwegian	3-1/5	12
Economy 12 or jumbo utility	4	12
Triple	5-1/3	12

The economy modular face size, 4 by 12 inches, is popular for use in large buildings because productivity is increased, and the unit's size decreases the number of visible mortar joints, thus giving large walls a different visual scale. Other sizes, such as Norwegian, 3 inch, non-modular and oversize, may be available. Table 1 contains face sizes of several modular brick units. However, thin brick may not be available in each size.



Fig. 4: These panels have 6-inch-square glazed white ceramic tiles and some additional 10-inch-square accenting blue tiles.



Fig. 5: Spandrels and wall panels on the Sylvan Corporate Center in Englewood Cliffs, N.J., have integrally cast 8-inch-square brick-colored tiles with pigmented mortar. Architect: Herbert Beckhard Frank Richlan & Associates

Some bricks (TBS, for example) are too dimensionally inaccurate for applications with precast concrete panels. They conform to an ASTM specification suitable for site laid-up applications, but they are not manufactured accurately enough to permit their use in a preformed grid that positions bricks for a precast concrete panel.

Brick is available from some suppliers to the close tolerances +/- 1/16 inch necessary for precasting. Close tolerances also can be obtained by saw cutting each brick, but this increases costs dramatically.

Whole bricks are generally not used in precasting because of the difficulty in adequately grouting the thin joints, plus the need to use mechanical anchors. Extruded cut brick may have kerf lines connecting the extruded holes; the purpose of which is to let the opposing brick faces be split apart by simply tapping the end of the brick with a mason's hammer.

Sometimes, both sides of the brick may be used as facing veneer. Special bricks with a sloping face are used at soldier courses or at the junction with a sloping face.

Ceramic Tile

Ceramic tiles should conform to ANSI A137.1 and are typically 3/8 to 1/2 inch thick. (See Figs. 4 and 5.) When several sizes or sources of tile are used to produce a pattern on a panel, the tiles must be manufactured on a modular sizing system in order to have grout joints of the same width.

Glazed units may craze from freeze-thaw cycles, or the bond of the glaze may fail on exposure. The body of a tile (not the glazed coating) must have a water absorption of less than 3 percent (measured using ASTM C373) to be suitable for exterior applications.

However, low water absorption alone is not sufficient to ensure proper selection of exterior

ceramic tiles. As a result, when ceramic tile is required for exterior use, the manufacturer should be consulted for frost-resistant materials for exterior exposure.

Glazes are covered by ASTM C126 and are tested in accordance with ASTM C67. Because glazed units have very low permeance to water vapor, it is recommended that a vapor barrier be installed on the warm side of the wall.

Terra Cotta

No ASTM standards exist for terra cotta, but units should meet the minimum requirements published by the Architectural Terra Cotta Institute. Architectural terra cotta is a custom-made product and, within limitations, is produced in sizes for specific jobs. Two thicknesses are usually manufactured: 1 $\frac{1}{4}$ - and 2 $\frac{1}{4}$ -inch-thick units. Sizes range from 20 to 30 inches for 1 $\frac{1}{4}$ -inch-thick units to 32 by 48 inches for 2 $\frac{1}{4}$ -inch-thick units. (Longer units available)

Tolerances on length and width are a maximum of +/- 1/16 inch. The use of terra cotta-faced precast concrete panels for restoration and new construction is illustrated in Figs. 6 and 7.



Fig. 6: Built in 1906, the architectural landmark 88 Kearney St. in San Francisco had its terra cotta removed and reassembled on precast panels for an all-new structure of taller height. Architect: Skidmore Owings & Merrill



Fig. 7: One-inch-thick brick cladding on 5-inch-thick concrete panels was used on the first three floors of the Sacramento County System and Data Processing Building in Sacramento Calif. Terra-cotta medallions were placed on spandrels and column covers. Architect: Ehrlich-Rominger

Production Methods

Clay product-faced units have joint widths controlled by locating the units in a suitable template or grid system set out accurately on the mold face. (See Fig. 8.) The most popular grid system consists of an elastomeric (or rubber) form liner. Liner ridges are typically shaped so that joints between units simulate raked (recessed) or tooled joints.

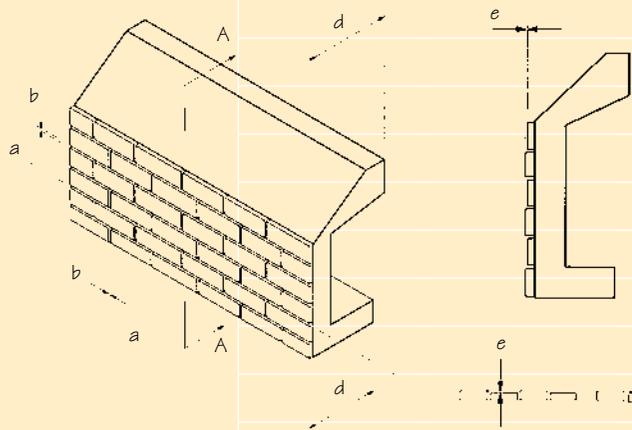
Clay-product units should be checked for tight fit and wedged if not tightly secured, especially on return sections, to prevent grout leakage to the exposed face of the panel or tipping of units. Tolerances for brick-faced precast concrete panels are shown in Fig. 9. The number of bricks that could exhibit these misalignments should be limited to 2 percent of the bricks on the panel.



Fig. 8: Thin brick is shown being placed in an elastomeric form liner.

Fig. 9: Tolerances for brick-faced architectural elements.

a = Alignment of mortar joints:	
Jog in alignment.....	1/8 in.
Alignment with panel centerline.....	±1/8 in.
b = Variation in width of exposed mortar joints.....	
	±1/8 in.
c = Tipping of individual bricks from the panel plane of exposed brick surface.....	
	+1/16 in., -1/4 in., ≤ depth of form liner joint
d = Exposed brick surface parallel to primary control surface of panel.....	
	+1/4 in., -1/8 in.
e = Individual brick step in face from panel plane of exposed brick surface.....	
	+1/16 in., -1/4 in., ≤ depth of form liner joint



The joints are recessed usually by 1/4 inch and sometimes are filled with either a 1:4 cement-sand mortar or with concrete. In the latter case, aggregate in the concrete for the joints should have a maximum size less than the joint width.

Steel reinforcement is positioned in the form, and connection hardware and handling inserts are located and secured. Then the backup concrete is placed in a normal manner. Cover depth of un-coated reinforcement must be a minimum of 1 1/2 inches to

the back of thin brick units or measured from the exterior surface of half brick units.

Galvanized or epoxy-coated reinforcement is recommended at cover depths of 3/4 inch. Joint depth and weather exposure affect the cover requirements.

Tiles, measuring 2 by 2 inches or 4 by 2 inches, may be supplied face-mounted on polyethylene or paper sheets and secured to the mold by means of double-faced tape or special adhesive. The space between the tiles is filled with a thin grout, and then the backup concrete is placed prior to initial set of the grout.

Applying Clay Products After Casting

Thin brick and ceramic tile as well as full brick have been applied to an already cast precast panel at the precast concrete plant and at the jobsite. Bricks generally bear on a panel ledge created by a recess on the precast concrete panel surface or on a projecting ledge.



Fig. 10: Glazed thin bricks are tapped into mortar using a rubber mallet.

Thin brick and ceramic tile may be applied to a recessed concrete surface using dry-set or latex-portland cement mortar once that surface has been properly roughened by sandblasting. (See Fig. 10.) Installation specifications for both dry-set and latex-portland cement mortars are contained in ANSI A108.5. When dry-set mortar is used, the necessity of wetting either the concrete surface or clay product is eliminated. Units should be grouted and tooled using dry-set or latex-portland cement grouts conforming with material and installation specifications in ANSI A 118.6 and A 118.10.

Full brick, supported on a concrete ledge or steel shelf angle, requires anchors for lateral support. (See Fig. 11.) The anchors should be flexible to permit slight vertical and horizontal movement parallel to the plane of the wall. This flexibility allows differential movements



Fig. 11: The perimeter columns and wall components of the St. Peter's Ambulatory Surgery and Parking Structure in New Brunswick, N.J., were cast with dovetail slots to facilitate quick installation of full brick in the precaster's yard. Architect: Desman Associates Photo: @Robert Mueller Architectural Photography

between the precast concrete and the clay product veneer without cracking or distress.

Wire anchors have a dovetailed steel-sheet bent over the wire that fits into a dovetail slot in the concrete panel. (See Fig. 12.) The dovetail adjusts vertically so the wire anchor can be placed in the bed joint of the brick. The size and spacing of anchors are based on tensile and compressive loads induced by wind suction and pressure on the walls.

To avoid anchor buckling, the distance between the inside brick face and the concrete panel should not be greater than 1 inch nor less than 1/2 inch.

Shelf angles may be used to support the full brick veneer at each floor, or at least every other floor, in place of a concrete ledge (see Fig. 13.) The shelf should be made of structural steel conforming to ASTM A36 and properly sized and anchored to carry the imposed loads.

For severe climates and exposures, consideration should be given to galvanized or stainless-steel shelf angles. When using shelf angles, continuous flashing should be installed over the angle. Flashing is not required if the masonry is supported on a concrete ledge, if the ledge has a slope of 1/8 inch in 5 inches, but weep holes are necessary in any case.

Horizontal pressure-relieving joints should be placed immediately beneath each shelf angle. Pressure-relieving joints may be constructed by placing a highly compressible material under the shelf angle and sealing the joint with an elastic sealant and backer rod. (See Fig. 13.)

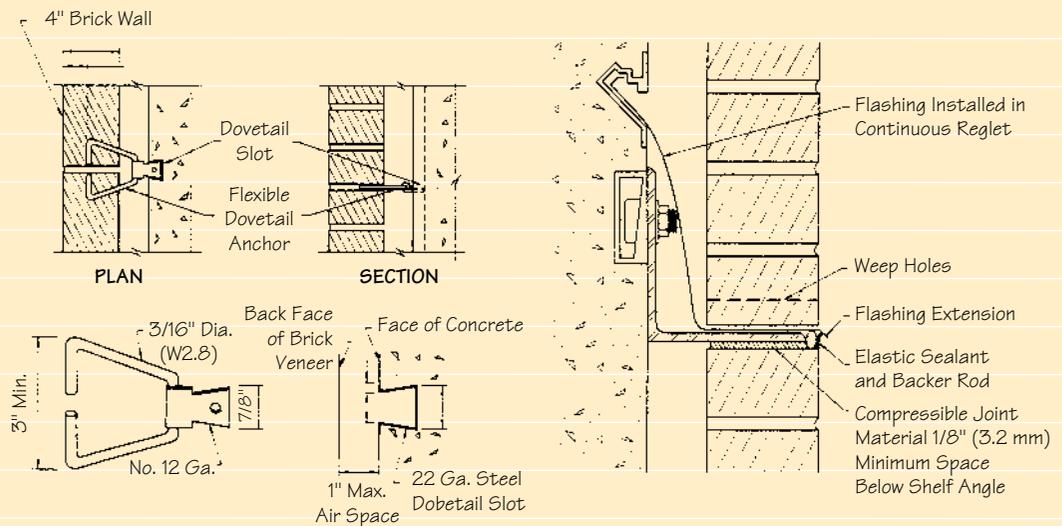


Fig. 12: The anchorage of brick to precast concrete using dovetail anchor and slot is shown here.

Fig. 13: Shelf angle with flashing and weep holes.

Work As A Team

Clay product-faced precast concrete panels offer a flexible and economical way to achieve the desired appearance through prefabrication. The designer must develop a good working relationship with both the precaster and the clay-product supplier so all parties are aware of expectations and potential problems with such elements as returns, soldier courses, joints and window details. The contract documents should define clearly the scope of veneer patterns. When this occurs as it should, the result is a pleasing combination of aesthetic beauty and durability.

Case Histories Offer Tips For Clay-Faced Precast Concrete Panels

Architect David B Richards, A.I.A., of Rossetti Architects uses some of his firm's recent projects to offer tips and techniques for using clay-faced precast concrete panels

Clay-Faced Precast Concrete Panels (CFPCP) combine the warmth of hand-laid masonry with the benefits of precast concrete panels. CFPCP have been the economical choice for several of our projects. In each of these, we intended the look and feel of a masonry building but determined the project was uneconomical to produce with actual masonry units. CFPCP allowed us to achieve the desired effect both on time and on budget.

The Arthur Ashe Stadium at the USTA National Tennis Center was enclosed early with CFPCP, allowing other trades to complete their work to meet a demanding schedule



Why Use Clay?

Traditional clay-brick buildings have a unique warmth and texture. Brick allows for the use of patterns through changes in color, size and texture. It also has an enduring quality. It offers a human scale and the appearance of solidity, quality, permanence and stability. Rowlocks, soldier courses and specially shaped brick are among the details that add visual interest and scale to a brick building. It's also a flexible material. Its small module adapts well to varying building shapes and lines. In general, brick has a special appeal.

CFPCP provide an opportunity for the combination of materials including brick, tile and a variety of colored and textured concrete. They can be an economical means of achieving the qualities of a brick building.

The patterns created with CFPCP can be grand or subtle. At the Palace of Auburn Hills in suburban Detroit, the home of the NBA Detroit Pistons, brick textures helped give the building scale and appeal. Both CFPCP and traditional masonry construction were used on this project. The upper portions of the building, where there are more repeated sizes of large panels, were constructed of CFPCP. Lower portions of the building where there was less repetition of panel sizes were later filled in with traditional masonry construction.

The pattern also allowed the metaphor for a basketball net to be realized.



At the Palace of Auburn Hills in suburban Detroit, the home of the NBA Detroit Pistons, dramatic brick textures help give the building scale and appeal.

Economics

Several Rossetti Architects projects have used CFPCP because the panels offered a more economical way to achieve the qualities of traditional masonry construction. Often times, traditional masonry construction was less expensive than CFPCP based on a direct cost comparison between brick with CMU back-up and CFPCP. However, cost savings related to rapidly enclosing the structure, building during winter weather and providing a solid back-up make a CFPCP an economical selection when the long-term picture is viewed.

Schedule



Orchestra Place Office Building in Detroit used precast panels to achieve a traditional, solid look.

On most projects, a precast concrete panel wall can be erected faster than a traditional masonry wall. This savings can reduce the overall time required to build a building and provide an enclosed space earlier. The schedule reduction alone can make the use of CFPCP more economical than traditional masonry construction.

Some projects, including the Palace in Auburn Hills and The Arthur Ashe Stadium at the USTA National Tennis Center in New York City, benefited significantly from early enclosure. Being able to quickly enclose all or part of a large building will allow other trades to begin their work earlier and reduce the overall construction time.

Sometimes the scaffolding and staging required for traditional masonry construction will tie up a site, making other operations difficult and extending the schedule. CFPCP are erected with a crane with minimal disruption. This provides another benefit to the schedule for the project that often is overlooked in the bottom-line estimates.

As with most precast concrete panels, CFPCP can be manufactured at the precaster's plant while other construction operations are on-going at the job site. The panels also are erected in large sections in less time than traditional masonry construction, which creates a shorter duration for construction.



*The brick surface texture on Orchestra Place in Detroit produced a subtle design in keeping with the building's function.
Photo: Balthazar Korab Ltd.*

Weather

Masonry construction is temperature sensitive. Special techniques, methods and handling are required for masonry construction generally when temperatures fall below 40 degrees F. In northern climates, the masonry often will need to be heated and kept warm during the winter, requiring expensive protection such as "cocoons" and heated with portable heaters to maintain minimum temperatures. Mortar can freeze at low temperatures and lose its bond and strength. These winter construction techniques add to the cost of the masonry construction.

CFPCP, on the other hand, can be erected during the winter without special protection at the site. They are manufactured in a controlled environment and protected at the precaster's plant, eliminating the need for winter protection at the job site.

Back-up

Most clay facings require some type of back-up support. Providing an appropriate back-up for the brick veneer can be an issue in larger buildings. CMU provides a good back-up for brick but, because of its weight, it can have a costly impact on the building's structural system. CFPCP can be designed to support their own vertical loads to the foundations, minimizing their impact on the superstructure.

Metal studs are lighter and stronger than brick, but they also are more flexible. The improper use of metal studs can lead to a wide array of problems and even failure of the wall.

Techniques

Several special construction techniques will help make a CFPCP project more successful. Using the right brick, tuck pointing the brick, using a double seal at panel joints and casting with cambered forms all contribute to the success of the precast product.

Brick

To ensure proper results, specify the use of ASTM C 216 FBX brick. Some brick are too dimensionally inaccurate for precast panel applications. Type FBX covers brick for general use where requirements call for a higher degree of precision and lower permissible variation in size. The tighter tolerances for size and reduced chippage help provide brick more suited to use in CFPCP.

The brick should be made with a dovetail core so that when cast into a concrete panel, it will have a mechanical bond to the concrete. It also should be kerfed at the core to allow it to be split by tapping with a mason's hammer.

The use of an extruded kerf may allow both brick faces to be used in the CFPCP. With some brick, however, only one face is intended to be exposed to view as a finished product. The other side may have belt marks or other deformations that will prevent the use of both halves in the CFPCP. Be sure to know and specify whether both faces of the brick should be used.

Defects such as chips, spalls, face score lines, cracks, and "finger marks" are common, and the defective bricks have to be culled from the bulk of acceptable units. It also is important to install brick from at least 2 different pallets in the forms to blend the varying colors of brick.



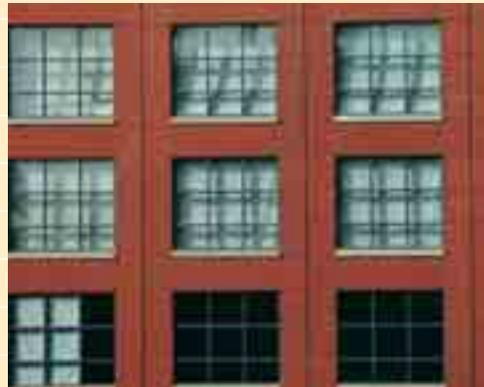
Oakland Commons Office Building in Southfield, Mich. features CFPCP to alternate with bands of glass to create a distinctive, contemporary look on an economical budget.



Kerfed brick with a dovetail core allows easy splitting of the brick and a good mechanical bond to the concrete.

Tuck Pointing

Tuck pointing the joints between the brick will give the wall a traditional hand-laid brick appearance. It also will help prevent water from entering the wall between the brick and the concrete.



At the USTA National Tennis Center, the brick was tuck pointed after being cast into panels. The weight of the precast concrete panels is carried on the foundations of the building.

Double Seal

The joints between precast panels are often made water tight with sealant. Sealant will deteriorate with exposure to weather and the sun's ultraviolet rays. An inner seal will not be exposed to deterioration from the weather and will provide a back-up should any water penetrate the wall. The inner seal is generally formed from another line of sealant and backer rod. The cavity between seals should be drained with weep holes.

Panel Flatness

The brick and the concrete will cure at different rates. As concrete cures, it loses excess water and shrinks while the brick has a tendency to expand when exposed to water. It is important to address this issue during design and manufacturing to ensure flat panels arrive at the job site.

Many factors can contribute to reducing or eliminating bowing, including the use of cambered forms. Forms with a reverse camber will compensate for bowing. The amount and location of reinforcing, the use of prestressing and the amount of water in the mix are all factors to consider in ensuring flat panels.

These techniques for designing with CFPCP have allowed Rossetti Architects to achieve the warmth and scale of a brick building while reaping the economic benefits of precast concrete. Using proper techniques in the design and construction of the panels will help complete the effect.

— David B Richards, A.I.A., Rossetti Architects, Birmingham, Mich.