The use of precast concrete (P/C) can serve as an effective off-site construction strategy, reducing the number of trade to trade coordination points; providing a reduction in materials (drywall and fire proofing); and a quicker and cleaner completed building. With on-site construction, there could be up to nine trades or more required on-site, including foundations, structural framing, metal/wood deck for slab, concrete slab placement, concrete curing, steel fire proofing, exterior facades, glazing and water proofing. However, with P/C, the required trades on-site are reduced to four or five, including foundation, P/C installation, topping and glazing.

Architectural panels with complex finishes can also be integrated into precast construction and provide structural support. Architectural precast envelope enhancements include: insulation, electrical boxes and conduit, windows, water faucets and finishes (such as brick or stone), that can be cast in at the plant.

Based on a webinar hosted by the Precast/Prestressed Concrete Institute and the National Institute of Building Sciences Off-Site Construction Council, “Precast Concrete Off-Site Construction: Techniques and Case Studies.” See http://www.nibs.org/page/oscc_webinar to access the webinar.
The Precast Plant and Quality Control

The precast plant is a place where precast prestressed products are manufactured in a controlled environment. They are usually large facilities consisting of a storage yard, raw material storage area, offices and casting beds outside and under roof. (See Figure 1). Standardized products are produced for structural building applications. Custom products are used for architectural facade applications (which usually enhance material for visual aesthetics).

Precast plant certification is over 50 years old. It ensures that each plant has developed and documented an in-depth, in-house, quality system based on time-tested national industry standards. The industry has two quality control (QC) manuals that are used by certified plants. These are the Precast/Prestressed Concrete Institute (PCI) MNL-116, *Manual for Quality Control for Plants and Production of Structural Precast Concrete Products* (see Figure 2), and MNL-117, *Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products*. PCI also has a plant inspector certification and a field certification program.

Comparative Construction Schedules (Precast vs Hand-Laid) and Finishes

One of the most competitive products in the P/C market is inlaid clay-faced brick products on concrete/insulated wall panels that will be cleaned at the plant and shipped to site. (See Figure 3.) Insulated load-bearing precast with brick inlay can be produced up to a two-story wall. Glazing can be considered at the plant depending on the plant and design of the panels. The manufacturer can incorporate mechanical openings so that it does not need to be done on site and, once placed, the mechanical components are rapidly installed. Electrical boxes and conduits can also be cast in the panel at the factory.
Examples of Complex Exterior Architectural Elements

1. The Broad Museum, Los Angeles, CA

![Figure 4: Broad Museum](image)

Project size: 120,000 square feet, including 2,500 glass fiber reinforced concrete (GFRC) panels.

2. Patricia and Phillip Frost Museum of Science, Miami, FL

![Figure 5: Patricia and Phillip Frost Museum of Science](image)

Custom form liners create the exterior of the west bar building. P/C panels create the self-supporting planetarium dome.

Case Studies

Confidential Facility, Saudi Arabia

**Precast Elements Used**
- Structural Building Decks: Hollow core planks
- Structural Walls: Exterior walls including architectural elements
- Architectural: Canopies, cladding, shading screens
- Utilities: Storm drainage, light pole foundations, perimeter security wall.

**Proposal Planning**

**Use of Prefabrication**

Planning begins at the proposal stage: Estimating, conceptual scheduling and the proposal approach were geared towards use of off-site construction methods. P/C was selected by the client during the proposal process because it was seen as an innovative construction method.

**Design-Build**

This method allowed for flexibility in the design. The request for proposal (RFP) included only basic architectural and structural performance requirements. The RFP did not indicate specific structural systems, which allowed the general contractors (GCs) to collaborate on the best approach.
Off-Site Construction Implementation Resource:
Using Precast Concrete as an Off-Site Construction Strategy

National Institute of Building Sciences     Off-Site Construction Council

Staged Project Turnover

The project had a critical schedule, with liquidated damages for failure to achieve the schedule. The scope required delivery of four identical buildings, each being three stories and 68,000 square feet. Each building had to be finished at the same time, including all supporting infrastructure, to achieve beneficial occupancy. This was difficult to meet with conventional construction methods and therefore P/C was chosen.

Difficult to Meet Contractually Mandated Turnover Date

In the project, the design development, design review, client review and design approval all had to happen before construction began. The most effective way for that to happen with the project time frame was to implement off-site precast construction methods. The construction schedule would be very tight if the project used conventional cast-in-place concrete decks and form systems. Early planning schedules included liquidated damages in the estimate for risk contingency (which increases price and reduces competitiveness).

Conceptual Design

process, multiple deck configurations were considered based on the efficiency of installation, reducing the number of different panel sizes, reducing bearing walls and increasing the flexibility of interior space inside the building by virtue of P/C. (See Figure 6.)

Proposal Schedule (Sensitive)

In order to meet the aggressive construction schedule, the early design of precast planks allowed for fabrication early so that elements could be ready to go on demand. This eliminated the purchasing/renting of large amounts of framework required with site-cast work. P/C also reduced the reinforcement quantity and installation versus cast-in-place decks. Further, the shaft opening was pre-cut in plant. In this project, precast panels could be shipped from the plant within one day of casting. Minimal labor was needed in this project for the precast deck installation: a total of two laborers for placement, one crane operator and two rigging men.

Early Delivery

In order to speed up the construction schedule, each precast deck was delivered before it was needed for installation as to not have any downtime.

Simple Installation

The precast decks were lifted into place with tower cranes. The planks only required 60mm bearing, which therefore avoided complex attachments. In this way, the panels were easily moved by two people with bars and the assistance of a crane.

Highland Park High School, Illinois

This project used a construction management (CM) at-risk contract structure. The project implemented a collaborative design phase, including the client, design team and GC. Target value design and lean construction principles were the focus. As such, early planning and decision making took place to maximize value to the client.

Value Adds

The project realized a schedule reduction of one and a half to two months. The owners reported cost savings due to materials and labor savings and reduced winter conditions that impacted the site schedule and quality of construction. The P/C components included interior structural elements, insulation and exterior architectural components (14” thick system at most areas) that integrated electrical.

Special Considerations

There were capable competitive bidders. There was significant wind load design and management during installation due to large planar elements on the crane hook. (See Figure 7.) The project required significant trade planning and coordination by virtue of one composite elevation using precast computer-aided design (CAD) software that integrates steel, electrical and plumbing. The precast elements included conduits and chases for ducts to the electrical and mechanical room for future power and heating, ventilation and air-conditioning (HVAC) needs. There were diverse types of dead man/brace systems to accommodate the existing soil and site conditions. The logistics of picking, staging and setting of precast elements was well considered and planned to minimize the number of crane operations and resultant cost.

Figure 6: Iterations to standardize panel sizes (Image courtesy of Gilbane Building Co.)

There were multiple structural systems considered in this project. The decision to use P/C hollow core decks became apparent early on in the project. Near the beginning of the project, the design team contacted precast companies to assess their capabilities. During the design...