

TOTAL-PRECAST CONCRETE SYSTEMS

Total-precast concrete structures (TPS) provide all the benefits of precast construction, with added value as a result of integrating structural, architectural, and other building systems. Architecture is combined with structure by integrating the exterior façade into a loadbearing system. Vertical shaft construction combines personnel and Mechanical, Electrical, and Plumbing (MEP) delivery systems with structural systems and advances construction access vertically through the project. MEP integration allows for the most efficient mechanical, electrical, and plumbing systems to be utilized, while structural and architectural systems are coordinated to accommodate necessary physical space requirements. Other peripheral systems such as windows, interior finishes, and embedded hardware are readily integrated into what was previously raw, core-shell construction.

Designing and constructing a total-precast concrete system requires familiarity with precast concrete design, fabrication, and delivery methods, so that maximum value can be realized. For owners, TPS may require financial decisions earlier than traditional program scheduling. Designers will be required to coordinate many of the integrated systems at earlier stages than normal program scheduling. Precast concrete manufacturers may be chosen at earlier stages of this process, many times at or prior to contractor selection. Working through these challenges effectively allows the owner to fully capture maximum value.

There are operational challenges that require advance planning. Size and weight constraints play a significant role in the design and cost profile of the precast concrete system components, making accurate and thorough operational knowledge an important part of early project discussions.



*NBSC Headquarters building, Greenville, S.C.;
Architect: Neal + Prince & Partners;
Photos: Metromont Corporation.*

Scheduling

Owners should be encouraged to expedite procurement of the required precast concrete knowledge and expertise, usually through a qualified producer who can supply the project needs. This can be accomplished either through design-build procurement or direct negotiation with a precast concrete supplier.

Traditionally, a design team might move through the schematic design (SD)/ design development (DD) phase of a project and into construction documents (CD), without intensive consideration of system integration. With TPS, this integration begins shortly after the SD phase, if not immediately at the onset of design schematics. With proper planning and the inclusion of experienced design professionals, this process flows smoothly. Effort normally allotted to the CD and construction administration (CA) phases of a project are significantly shifted to the SD and DD phases, as functional systems and finishes are integrated into the basic core/shell design. This allows both the contracting group and design team to operate more effectively once construction commences, as the major core/shell coordination is substantially complete and emanating from a sole source, the precast concrete manufacturer/erector. Contractors and designers spend less effort coordinating conflicts and more time with forward planning of site and interior finishes.

Architectural Design

To obtain the maximum benefit for the owners as finishes and systems are integrated into TPS, the architect must understand simple challenges such as size and weight of precast concrete components planned for the structure. Many elements of the architect's design palette are affected by these simple parameters and therefore they should be understood early in the design process.

Exterior finishes, reveal patterns and panel shapes all require attention to panel thickness and concrete cover. The structural support wall panels provide often require minimum panel thickness for proper detailing of floor or roof elements such as hollow-core or double tees. These details must be combined to ensure the final finish quality is of appropriate quality and acceptable appearance.

Window tolerances and detailing requires careful consideration of how openings are sized, located, and coordinated with the reveal or rustication design required on exterior surfaces. With careful detailing, site tolerances can be made more liberal without negatively impacting the aesthetic design.

Panelization of the exterior façade defines joinery that can be manipulated within these detailing constraints, to accomplish required aesthetics. Strangely enough, mundane issues such as shipping and handling may become the challenges that will require the most attention. For every project location, there are weight and size constraints required for shipping that the local precaster can identify and help coordinate. In addition, specific operational limitations that are both plant- and site-driven, can sometimes influence panel weight and size limitations.

Various patterns integrated into formwork. Nimitz-MacArthur Pacific Command Center, Oahu, Hawaii; Architect: Wimberly Allison Tong & Goo Design; Photos: Gary Hofheimer Photography.



Structural Design

As architecture and building systems are integrated into the structural system, the precast concrete design engineer is presented with new and varied challenges. With proper team coordination and knowledgeable resources, the engineer can create the necessary structural system while accounting for this integration.

Notches and setbacks are particularly challenging in any structural system. TPS must carry the weight of the loadbearing façade when these design features are required. Utilizing transfer beams, prestressing capabilities, and other panelization techniques, these types of features can be effectively crafted into the final structural design.

Floor-to-floor height requirements for MEP systems are coordinated through design modification to the main girders, dapping of double-tee floor components, or by providing pre-coordinated openings in the precast framing. While many openings can be readily field cut, it is advantageous and cost effective to incorporate as much of this in the manufacturing process as possible.

Early coordination provides a good opportunity to combine foundation systems into total-precast concrete systems, particularly when using grade beam/pier foundations. Below-grade foundation wall systems and other foundation-related systems can be readily integrated into the TPS, providing the contractor/owner with added scheduling flexibility.

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