Northrop Grumman Aerospace Systems Manned Aircraft Design Center of Excellence – Building 228 project reached completion 58 weeks from the start of design to occupancy, and 42 weeks from groundbreaking to occupancy. *Photo: The Austin Company/Northrop Grumman*

A structural steel framing grid was employed with an exterior cladding system comprising approximately 400 precast concrete panels. *Photo: The Austin Company/Northrop Grumman*

SCHEDULE-DRIVEN DESIGN

PRECAST CONCRETE CLADDING AND STRUCTURAL STEEL FRAMING ENABLE FLEXIBLE SEQUENCING TO MEET A COMPRESSED CONSTRUCTION SCHEDULE.

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IN EARLY 2013, Northrop Grumman announced the creation of five Centers of Excellence around the country to improve its strategic alignment with customers' need for increasingly innovative and affordable products, services, and solutions. Northrop Grumman selected The Austin Company to provide architectural design, engineering, and construction management services in support of this national program. Northrop Grumman's campus in Melbourne, Fla., was designated as one of the five Centers of Excellence — A Manned Aircraft Design Center of Excellence. In support of this designation, Northrop Grumman relocated one of its major manned aircraft programs from Bethpage, N.Y., to the Melbourne campus, requiring construction of Building 228.

To meet the target schedule for this relocation, the new 210,000-square-foot building would have to be implemented in just over one year. The approach required flexibility to develop design and engineering drawings out of traditional sequence. A project-specific Risk Points and Mitigation Measures Plan helped identify potential risk factors, with a Work Package Control Schedule serving as the project "guidebook" and work plan for design, engineering, and procurement activities.

Austin's design and engineering team was driven by the construction schedule and maintained close coordination with Austin's Construction Management team. Following this fast-track schedule, the project reached completion 58 weeks from the start of design to occupancy, and 42 weeks from groundbreaking to occupancy.

Construction sequencing was devised so that the early shipments of concrete panels were being erected before the structural frame erection was complete. This approach required careful selection of support details and field coordination.

Due to the extreme overlapping of design and construction for this project, it was necessary to devise all building systems to allow for change during construction as final design decisions were made. In short, engineering and construction proceeded based on the best information available at the time, and then was adjusted.

To this end, a structural steel framing grid was employed with an exterior cladding system. Use of the exterior skin as load-bearing or shear elements was not considered because of the required flexibility requirements described above.

Several veneer cladding systems were considered, such as glass fiber-reinforced concrete and insulated metal panel. However, these systems lacked the intrusion resistance and outright durability of concrete. The exterior walls of this building are required to resist hurricane-force winds, wind-driven rain, and impact by large debris resulting from high winds. The efficacy of concrete panels was evident.

While the building envelope system was being finalized, certain design assumptions had to be made in terms of how to support the exterior cladding system during the structural steel design to meet the aggressive schedule. The precast panels, along with the glazing system, had to be designed to withstand components and cladding wind pressures of up to approximately 100 pounds per square foot due to the ultimate design wind speed of 150 mph, as required per Florida Building Code.

Overall, approximately 400 pieces of precast panels were used, including the service yard enclosure panels. Most floor-to-floor solid panels were stacking and self-supporting by gravity on the concrete pad footings, while connected to the slab-on-grade and the floor deck for transferring the lateral (wind) forces. Spandrel panels and column panels were supported by the exterior steel beams and columns. A few panels were supported on the elevated floor deck, due to the unique building enclosure configuration at certain locations.

Building information modeling (Revit) was used to coordinate every single connection between the precast panels and the structural steel. Not a single significant structural steel modification was made to accommodate the precast panel connection in the field. A number of openings were also carefully coordinated on certain panels to allow the structural steel penetrations to support the canopies at the building entrances.

Use of architectural panels with the long dimension horizontal allowed for panelization consistent with the overall aesthetic, and allowed for pleasing joint and reveal locations without increasing material cost. *Photo: The Austin Company/Northrop Grumman*

The architectural precast panels were of the insulated type, which reduced thermal conductance. Managing the shop drawing submittal process on an aggressive schedule while not sacrificing the thermal value of the panels was challenging, but ultimately successful.

Building design

With an anticipated 50-plus-year building life and changing program assignments, the facility design affords a high degree of internal flexibility, capacity, and security.

Internal flexibility is provided by three large floor plates and the location of building support cores at the building perimeter, rather than at the center of the floors. Lab and a portion of the office areas are located on access flooring to facilitate utility delivery and spatial reconfiguration. Partitions are located on-module to minimize disruption in future reconfigurations.

Security is viewed from two perspectives — physical access to and within the building; and protecting the building, its occupants, and sophisticated equipment from potentially harsh Florida hurricanes and flooding.

From an aesthetic standpoint, the use of architectural panels with the long dimension horizontal allowed for a panelization consistent with the overall aesthetic, and allowed for pleasing joint and reveal locations without increasing material cost. Both architectural and functional elements are employed to achieve this result and include a rhythm of architectural precast concrete and fenestration with horizontal lights and sunshades.

Exterior architectural precast panels run laterally and are designed with strong horizontal reveals and decorative metal banding to emphasize the horizontality. Windows utilize low-e high-performance and hurricane projectile-resistant heavily tinted blue glazing. Concrete panels omit glazing altogether in areas of highest security and instead utilize a ribbed pattern design. A prominent roof feature is the 80-foot-diameter specialized aircraft equipment enclosure, which shields equipment visually and functionally.

Project challenges

The project also mandated innovative approaches for the specific technology required. The unique integration and simulation lab conditions to support the user program placed special requirements on the building across multiple MEP, architectural, and structural systems.

A particularly unique challenge occurred during construction. The building includes a technology on the roof to support program functions relating to the user program. As the structural steel was being erected (more than 65 percent complete), the program team determined that the three large main air handler penthouses atop three building perimeter circulation towers were going to interfere with this technology — the towers could not exceed the height of the parapet on the balance of the building and the air handlers would have to move.

The A/E team quickly accommodated the air handlers within the building without compromise to the functional layout of the building floors and reworked the distribution ductwork. A few, very limited structural steel changes were made, precast panels revised in fabrication, and "no one was the wiser" to an otherwise major design change. Not one day in schedule was lost.

LEED certification

The Building 228 project is striving for LEED Silver certification and required a high level of energy efficiency to obtain the necessary performance criteria. The site, a reclaimed brownfield, effectively manages stormwater discharge in terms of quality and discharge rates, provides priority parking for fuel-efficient vehicles, and reduces the heat island effect by means of concrete pavement in lieu of asphalt. Landscaping irrigation is provided by a municipal gray-water system.

The precast panels were continuously insulated from edge to edge to meet ASHRAE 90-1 requirements for continuous insulation. The inner and outer concrete faces were connected thru the insulation with a series of non-metallic composite ties. This formed a robust structural concrete-insulation-concrete sandwich with excellent thermal qualities. The composite ties prevent the transfer of thermal energy through the insulation that is typical with metal ties. This contributed to the overall high thermal efficiency of the precast wall panels. The joints between panels used spray foam to provide continuity of the insulation and were caulked to provide a weather-tight joint.

BIM was used to locate and coordinate the panel and connection design. The structural steel model was utilized as a reference to attach the precast design. Several coordination meetings were held "virtually" so that team members from multiple locations could participate to expedite the shop drawing creation and review process.

Successful outcome

Nearly 1,400 construction tradesmen worked on the project up to 18 hours a day in shifts, six days a week, over the course of the project. At any time, more than 300 construction tradesmen and supervisors were working on the project's construction.

Building 228 is a true demonstration of what can be accomplished when a team focuses on what can be done, and not on what cannot be done.

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