Over the Top

BY ROBERTO A. SMITH, AIA AND ARA PETROSSIAN

By James Wilkins.

Miami International Airport's new Concourse J features structural steel bones supporting curvilinear, airplane-like surfaces.

Roberto A. Smith, AIA is a principal with MGE Architects in Coral Gables, FL.

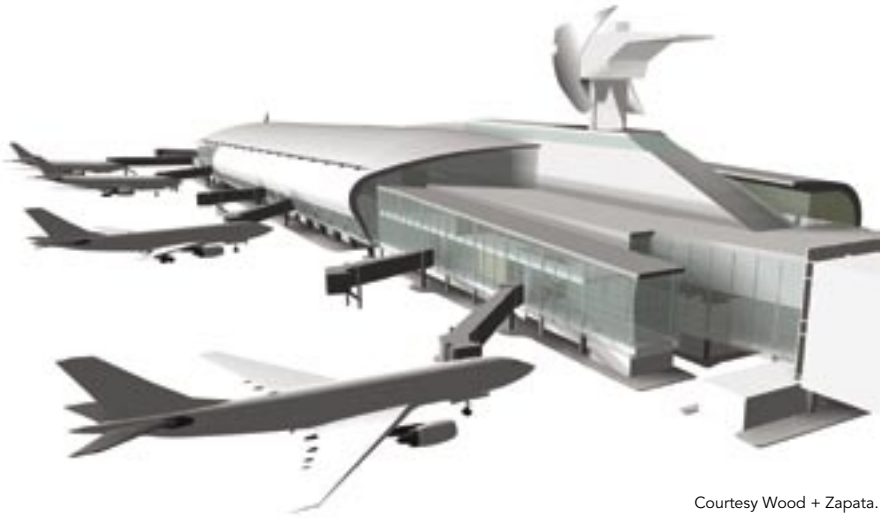
Ara Petrossian is a senior associate and senior structural engineer for DMJM Design in Arlington, VA.

MIAMI INTERNATIONAL AIRPORT'S NEWEST CONCOURSE FEATURES A VAULTED STEEL STRUCTURE—PROVIDING BOTH THE ROOF AND WALL STRUCTURES—THAT POSED SIGNIFICANT DESIGN CHALLENGES. Construction of "Concourse J," which began September 2002 at the southeastern tip of the airport's main terminal, is expected to be completed by the end of summer 2006.

The $100 million project is part of $4.5 billion airport expansion and renovation. Concourse J, which will complete the main terminal's southern expansion, features 15 gates and a 340,000 sq. ft facility that measures approximately 840' by 120' on seven levels.

Vaulted Roof

The use of steel construction was necessary to support the concourse's complex architectural design. The most



This cutaway rendering shows how the steel shell forms both the roof and walls of the building.

Courtesy Wood + Zapata.

challenging structural aspect of this design was the vaulted roof structure, which covers the entire building.

The roof starts from the third floor, on the west side, and ends at the second floor, on the east side, of the building. Curved steel rib members are used to form the steel roof shell, which functions as both the roof and walls of the building. Several types of steel bracing were used both length-wise and width-wise in different bays and were spaced accordingly to satisfy the architectural needs of the superstructure.

The roof is supported by primary curved rib members and curved roof trusses which are spaced 30' on center. These wide-flange, built up steel rib members vary in flange depth, tapering from 33" at the top of the vault to 12" at the second floor. Each rib has several radii, and no two ribs have the same geometry.

The steel roof shell was connected to 1½" steel deck at the top of the filler beams and to the steel angle bracing at the bottom of the filler beams. Cross-bracing was designed similar to a horizontal truss to transfer lateral forces to the vertical steel bracing bays. The structure was designed to transfer wind uplift to the primary members, which are spaced 30' on center. All base connections for these members were designed to withstand the combination of uplift and lateral loads.

On its south end, the shell structure cantilevers 36'—another challenging aspect of the design. This was accomplished by using vertical bow truss supports that extend from the second floor to the bottom of the vaulted roof (about 40' in vertical height). They are spaced at 10' on center and consist of 6"-diameter tube members. These vertical trusses support the entire exterior glazing and provide support for the vaulted roof, as well.

The roof's exterior is finished with an aluminum standing seam roof covering, which was specified by the architects but did not serve as a structural component. These assemblies were attached to the roof deck by mechanical fasteners to resist the wind uplift.

Mechanical Systems

The mechanical systems serving the building are all hidden within the vaulted roof. All equipment is housed in an "inner linear building" that spans the full length of the vaulted structure as a separate entity. Roof wells were constructed in the upper portions of the vault in cutaway sections that conceal exhaust fans and smoke evacuation stacks from view.

The roof well in the center of the building is approximately one-third the length of the building and 23' in width, consisting of a 5¼" composite floor slab and pre-cast concrete tapered side walls.

Building Structure

Concourse J allows uninterrupted domestic and international access throughout all portions of the terminal's seven levels. Composite steel framing is used for the floors. The vaulted roof is supported at the edge of the second floor on the structure's east side and the edge of third floor on the west side. Intermediate steel column supports extend from the top of the pile caps to the bottom of the roof.

Building grids are 30' along the long axis and average about 24' on the short axis. The second floor was designed to accommodate heavier moving loads with a 3", 19 gauge composite steel deck with 6¼" lightweight concrete. The remaining floors use a 2", 19 gauge composite deck with a total of 5¼" lightweight concrete.

The center of the building is wider and taller than the northern and southern tips of the building. Steel allowed the building to span across the departure lounge seating area uninterrupted by columns.

The entire building is divided by two expansion joints that accommodate longitudinal movements due to wind and temperature effects.

Modeling

The entire structure was modeled in three separate segments using RISA-3D. A total of 12,000 members were used to model the exact structure. It took approximately six months to create a "perfect" model, which included many different load combinations. These included hurricane wind inputs and input loads, which were conducted independently by a wind tunnel study on a smaller proportioned model of the building. All members were designed based on output results from RISA-3D.

By Aerial Photography, Inc.

Roof wells concealing mechanical equipment are plainly visible in this aerial view. The roof well in the center of the building is 23′ wide and stretches for approximately one-third of the building's length.

Fabrication

Collaboration of the design team with the steel fabricator and erector was necessary in generating the geometric design of the concourse. Without teamwork, the geometry of the building design would have been compromised. The tight clearances required at the edge of the building where the roof meets the wall were closely monitored in the steel design process in order to allow for the tight fit of the escalators and power walks that hug the building's exterior.

The design team provided a chart of building geometry and dimensions that allowed the steel fabricator to generate all of the structural components for each unique vault.

Owner
Miami-Dade Aviation Department, Miami-Dade County, FL

Architect of Record
MGE Architects, Coral Gables, FL

Design Architect
Wood + Zapata, New York

Structural Engineer of Record
DMJM Design, Arlington, VA

Engineering Software
RISA-3D

General Contractor
Parsons-Odebrecht Joint Venture, Miami

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On its south end, the shell structure cantilevers 36′. Vertical bow truss supports composed of 6″ round sections extend from the second floor to the bottom of the vaulted roof.