MUSEUM SALUTES THE STRATEGIC AIR COMMAND

Large clearspan hangars are required to house the exhibits at a new museum in Nebraska

By Dan Tablbott, P.E.

During the decades of "The Cold War," the Strategic Air Command served as the first line of defense in case of a nuclear attack against the United States. The elite unit operated until 1992, when the collapse of the Soviet Union triggered the meltdown of the Iron Curtain. Instead of letting the memory of the historic unit fade, the legacy of the Strategic Air Command (SAC) is captured in a museum completed recently near Ashland, NE.

The Strategic Air Command Museum, which opened to the public in May, presents an impressive display of aircraft, missiles, educational exhibits and thousands of other items amassed since 1959. The 33 aircraft include B-17, B-29, B-36 and B-52 intercontinental bombers; F-84 and F-86 fighter/interceptors; an EC-135 "Looking Glass"; a U-2 and SR-71 Blackbird high-level reconnaissance planes. The location along Interstate Highway 80, between Omaha and Lincoln, is expected to attract as many as 600,000 visitors a year.

The SAC Museum Memorial Society once operated the museum from a 22,000-sq.-ft. building at Offutt Air Force Base where the aircraft were stored outside along an inactive runway. Extended exposure eventually threatened the historic aircraft's preservation and the US Air Force considered reclaiming the planes. A group of Omaha-area business leaders and retired military personnel spearheaded the Society's $29.5 million capital campaign to build the 250,000-sq. ft. of facilities needed to relocate, restore and permanently house the collection inside.

More than 1,800 tons of structural steel, 500 tons of reinforcing steel and 23,000 cu./yds. of concrete were molded into the project. Some 900,000 cu./yds. of earthwork was also necessary to prepare the 6½ acres for the buildings and parking areas developed at the rolling, 40-acre site.

The four structures in an L-shaped plan pivot off the Exhibition building whose atrium lobby is flanked by two large hangars. A two-story Administration Building is behind the lobby and between the hangars.

Main Lobby

The Exhibition Building consists of a central lobby flanked on both a truncated conical form with nearly 15,000-sq. ft. of glass. The 107' x 157' structure rises more than 70' above grade with a 110' maximum span. This portion of the museum houses a 200-seat theater, offices, display exhibits, gift shop and support areas.

The lobby centerpiece is a supersonic SR-71 Blackbird photoreconnaissance aircraft displayed at a 30 degree bank and 10 degree dive angle. The plane was set atop three pilons prior to enclosing the atrium with a glazed, tubular steel space frame system. Glazing consists of 1-3/16" clear insulated units on sloped areas and 1" insulated glass on vertical walls. Metal frames supporting the glazing are integrated with the space frame by threaded saddle connectors at each node of the space frame.

A 50' high concrete wall defines the building's L-shape with an 18' high radius concrete counterfort retaining wall connecting the two legs. The concrete walls support the vertical loads from the space frame, with the counterfort wall providing lateral load resistance for the system. Supported on steel pipe pilings, the L-shaped walls cantilever from the ground floor up the entire height.

The structural system for the atrium area is supported on steel haunch thru-bolted in the 3' thick concrete walls. These haunches carry only the skylight's vertical loads as supports rest on frictionless bearing pads designed to prevent lateral load transfer. All lateral loads from the space frame/skylight are resisted at the top of the radius counterfort retaining wall. This 18' high wall permitted construction of grades that establish the museum's entry at an observation deck level. This deck employed a conventional steel frame with composite steel metal deck and lightweight concrete fill. It extends into both hangars so that visitors can view the aircraft from an elevated perspective.

The design adhered to the 1994 Uniform Building Code. Snow load provisions included a uniform loading and a 60 psf unbalanced condition, 5 psf collateral load, 90-mph wind speed and Exposure "C". Each primary frame also was engineered to accommodate a 5000-pound load imposed by suspended aircraft

and the columns to support the observation deck. An interior door in one hangar separates viewing and maintenance areas. This presented another special engineering consideration, forcing the designers to accommodate the door in combined open or closed-door positions.

Primary structural frames are 10'-deep trusses spaced 40'-on-center that create a 286' radius. The trusses are supported on steel double columns ranging in size from W14x109 to W14x159. Wall heights are 37', with the bottom chord of the arched trusses reaching 60' above the center floor area. The bottom and top chords of the trusses range in size from W14x30 to W14x120, while the diagonals consist of double angles ranging in size from 3½ x3x¼ to 5x5x½. Each truss was fabricated in seven, 35' to 40' segments to facilitate transportation and erection. As a time and cost-saving alternative to cold rolling, the fabricator used a camber press to bend the W14 chord sections about their weak axis. These sections ranged from 30 to 120 pounds per lineal foot. The trusses were then shop fit with column assemblies to streamline erection. The lateral load resisting system for the building includes both rigid and braced frames. The braces consist of 8x6x7/16 double angles.

Pre-engineered building components in the mix of structural steel consisted of standard 40' joists, 9½" wide x 12-gage, cold-formed Z-girts, 24 gage standing seam metal roof, insulation barrier and a 22-gage, and 1 ½" corrugated acoustical liner. The 26-gage metal wall panels clad the 150' x 35' hangar doors and the balance of those endwalls.

Sway bracing and horizontal bracing between the trusses was designed to permit ground assembly as paired segments for greater erection safety. This also provided better stability and faster cutaways during the tandem crane picks. Six segments for each truss pair and sway bracing were bolted on the ground into parallel units, lifted and set on each column.

Once tied off at the column, the crane closest to the column repeated the procedure on the other side. A third crane was then used to set the center section needed to complete each truss.

Hangar Design

The 270' x 360' and 270' x 400' hangars are the most physically dominant and the most complex elements in terms of their engineering. The hangars were inspired by the arched-roof structures common at U.S. Air Force bases in the past. Both are expandable, with one capable of accepting three bays and the other building an additional four bays. The point loads imposed by the aircraft required floors ranging from 6" thick slabs at the perimeters to 10" in the center. The buildings are supported augered, cast-in-place 14" and 16" diameter piling with 16" square tie beams connecting the pile caps on opposite sides of the structures to resist the kick out force generated by the arched roof frames.

The museum's hangars are hybrid structures, employing fabricated steel framing with pre-engineered metal building secondaries with a proprietary standing seam metal roof system installed and fitted with a custom fabricated acoustical metal liner panel. The metal wall panels on the two ends with hangar doors are supported by cold-formed girts.

The pre-insulated concrete wall panels have a ribbed exterior finish and were cast with a color tint. These 37' high units clad the other three sides of each hangar. Lateral loads from the top are supported by light horizontal trusses integrated with the truss bottom chord bracing and span column to column. The 90' x 90' Administration Building is a two-story structure designed as a steel moment frame with composite metal deck floors infilled with lightweight concrete. The exterior walls are 6" metal stud construction with an exterior insulation finish system (EIFS). The ground floor is a 5" slab on grade.

Project Team

Owner:
Strategic Air Command Memorial Society

Structural Engineers:
Butler Heavy Structures, a Division of Butler Manufacturing Company

Architect:
Leo A. Daly

Contractor:
Kiewit Construction

Fabricator:
PKM Steel Services

Detailer:
PKM Steel Services

Administration Building Design

The facilities were in place by November 1997, following an 18-month design and construction schedule.

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