# Mineta San Jose International Airport

## DELIVERING FORM AND FUNCTION

*By Terry L. Palmer, P.E.*

*Figure 1: San Jose's newest airport terminal and concourse elegantly marry form and function, readily meeting traveler needs while embodying the spirit of the Silicon Valley in a shape reflective of an unraveling fiber optics cable. Courtesy of Magnusson Klemencic Associates.*

On a recent shuttle bus trip to Mineta San Jose International Airport, the new airport terminal and concourse came into view (*Figure 1*). My fellow passengers came alive with spontaneous comments that were overwhelmingly positive: "Wow, that's a sexy looking building." "It's beautiful." "I can't wait to use it! We've needed a new terminal for years." Achieving this reaction was no accident; it was the result of insightful leadership and smart decisions. The airport authority, and the project's design and construction team, worked hard and cohesively to create a new form that functions well and leaves a lasting impression on those who travel to the Capital of Silicon Valley. It's clear to visitors and locals alike: San Jose has a sparkling new airport that embraces form and function.

## Travel Planning 101: Be Flexible and Adaptable

For years, the San Jose Airport operated out of Terminals A and C, both of which had significant operational and cosmetic issues. The roadways, parking, and rental car facilities were not up to par, especially on busy travel days, and post-9/11 passenger screening requirements were causing long, unacceptable waiting lines for passengers. It was clear San Jose needed a new airport.

Gensler, as Master Architect, held several community outreach meetings and workshops with airport staff to clearly define the airport's vision, budget, and needs. The existing airport site is constrained by the Guadalupe River and Highway 87, leading to a linear solution for the concourse and terminal.

It soon became clear that the new concourse structure needed to accommodate an architectural design that was still evolving: the airport vision was being defined, room locations were not set, the bag conveyor system was conceptual, and interior and exterior designs were in flux. Yet, even with the terminal and concourse shape in the midst of formulation, early construction packages for excavation and structural steel had to be released for bid. In response, the structural solutions developed allowed a great deal of design flexibility.

## Economical, Dry Bag Storage Beneath Your Feet

For long-term adaptability, the airport wanted a basement below the concourse to house utilities, bag conveyors, equipment, and storage. During the schematic design stage, the design team was directed to produce an early bid package that included the basement excavation, dewatering, and shoring walls. Because the ground water on site can rise up to within 5 feet of grade, minimizing the depth of excavation was very important. The cost of dewatering and the hydrostatic uplift pressure increased dramatically the deeper the hole became. Two solutions were developed to minimize basement depth:

- Precast concrete tension piles driven into the ground below the basement level, with a reinforced concrete mat foundation. The pattern developed for pile placement reduced the mat foundation thickness by several feet.
- A reinforced concrete flat plate ground-floor structure. This solution reduced the structural depth of the floor by about 2 feet compared to conventional steel beam and composite deck.

These features alone reduced the cost of excavation and substructure by over $10 million. The basement readily accommodates the required bag conveyors and additional equipment, with capacity for future systems as well.

*continued on next page*

*Figure 2: Following careful evaluation of options, a unique earthquake-resisting structural system known as a special truss moment frame (STMF) was selected, in a first-ever use at an international airport. The STMF system, which uses steel trusses to resist gravity, seismic, and wind loads, is cost effective, quickly erected, seismically robust, flexible, and adaptable. Courtesy of Magnusson Klemencic Associates.*

*Figure 3: At the suggestion of the design/build team, led by Hensel Phelps, the new Terminal B was moved to the north and tied directly into the concourse, without seismically separating the two buildings. Courtesy of Hensel Phelps.*

## Not Your Typical Restraint System

Selection of the lateral-restraint system was one of the design team's most important decisions. Braced- and moment-frame systems were evaluated based on cost, speed of erection, seismic ductility, adaptability to design changes, and capacity to accommodate future expansion. Ultimately, the team selected a special truss moment frame (STMF) as their preferred system. Although STMF systems have been implemented for other important facilities such as hospitals, this was the first use of an STMF structural system at an international airport.

The STMF system (*Figure 2, page 35*) is a unique form of moment-resisting frame with steel trusses used to resist gravity, seismic, and wind loads. The design of the STMFs restricts inelastic response due to earthquake loading to special segments located in the middle half of the truss spans. As such, the system is a very ductile and robust seismic-restraint solution – critically important in a high seismic region such as San Jose.

The STMF trusses proved to be fairly easy to fabricate, pre-assemble, and ship to the site. In addition, field connections between the truss and the support columns required only fillet welding, thus avoiding slow and expensive complete-penetration welds. The STMF also simplified routing of ventilation ducts, pipes, and conduits, as many of these services could be located between the truss diagonals and through the center special segment.

Even though structural steel prices were rising radically upward at the time, the concourse steel bids came in several million dollars below budget. Furthermore, the structural steel was erected ahead of schedule.

## Sleek, Silver, and Silicon Style

As Gensler's interior and exterior design firmed up, the City Council approved an architectural shape that embodied the spirit of San Jose and the Silicon Valley. Gensler's vision included an interesting curvilinear exterior landside façade, with a skin that is both transparent and glistening day and night – somewhat reflective of an unraveling fiber optics or data cable. Within the concourse on the airside, a curvilinear transparent roof was designed to celebrate dappled, natural light as it cascades onto a fabric Paseo canopy. The combination of the concourse shape and light produces a truly startling effect and a unique sense of place.

To create economical curvilinear shapes, MKA developed straight-line-generated curves that allowed most of the structural support members to be straight, rather than physically curved. Many of the cladding elements were created from straight-line faceted panels. Other cladding elements were supported on a metal roof deck that bends naturally along the weak axis of the deck. In areas where curved members were necessary, the radius of the curve was repeated to minimize set-up time and fabrication costs (*Figure 3*).

## Adapting to Changes in Itinerary

Once construction of the concourse was well underway, the airport solicited design/build proposals for the next phase of construction, the Terminal Area Improvement Project (TAIP), which includes Terminal B and a renovation/expansion of Terminal A. The winning design/builder, Hensel Phelps Construction Company and Fentress Architects, reconciled the TAIP scope and value-engineered the program while building upon the original City-Council-approved vision for Terminal B. In collaboration with airport staff, Hensel Phelps suggested moving Terminal B to the north several hundred feet and tying it directly to the new concourse. This shift produced great cost savings, as it eliminated a planned temporary terminal, allowed the bag conveyor system to be placed within the concourse basement, and utilized already-constructed new concourse airside hold room space.

This design shift was possible because the concourse structure was designed with expansion in mind. In fact, the timing was just right for the Terminal B structure to be attached directly to the concourse structure, eliminating costly seismic separation joints and a cumbersome double row of columns. In essence, the wisdom of implementing an adaptable and expandable structure proved tremendously cost-effective.

The design/build team determined that the most effective method of creating the curvilinear form of Terminal B would be to construct the roof using curving wide-flange beams welded together to create tubular shaped ribs at 30 feet on center. The deep acoustical roof deck spans 30 feet between the arched roof beams to create a very open and inspiring space within the baggage claim area and the passenger screening mezzanine. Curbside, in front of Terminal B, the arched roof ribs are supported on three Teflon-coated bearings (*Figure 4*), which allow the terminal roof to slide during major seismic events.

## Navigating through the Airport

A fully integrated Revit building information model (BIM) of Terminal B was developed by the design team (*Figure 5*). The design/build team employed the use of an integrated BIM model to minimize conflicts between systems, speed up construction, and document existing conditions for future building operations. Although the BIM model was not

*Figure 4: The arched roof ribs of Terminal B are supported on three Teflon-coated bearings which allow the terminal roof to slide in the event of a major earthquake. Courtesy of Magnusson Klemencic Associates.*

finalized until construction of the structure was well underway, Hensel Phelps has seen a substantial reduction in field changes attributable to interferences between separate systems. The BIM model was also very effective during installation of the intricate baggage conveyor system, shortening the installation time substantially.

## Passing through Security

Secure solutions were integrated into the design and layout of Terminal B, the Terminal B Concourse, the roadways, and the new Rental Car Garage. MKA performed blast analysis to establish parameters for parking, fuel tank locations, vehicle check points, and vehicle barriers without impeding the operation of the airport or approach roadways. These secure solutions were woven into the design in a manner that avoided adverse impact to cost or the architectural design of the terminal and concourse.

Many sustainable design features were also employed in Terminal B and the concourse to achieve LEED certification, including natural light, extensive use of recycled materials, efficient structural systems, and a displaced air ventilation system.

## Unmatched On-Time Arrival

The new Mineta San Jose International Airport celebrates form and function. The design embodies the rich cultural and high-tech image repeatedly expressed during formulation of concepts for the new airport. A great deal of vision, innovation, collaboration, and hard work by all parties contributed to the successful execution. The message is clear: "Welcome to San Jose, California, the Capital of Silicon Valley."▪

### Project Team

*Terminal B Concourse*

Architect – Gensler (also airport Master Planner)
Associate Architect – Steinberg Architects
Structural – Magnusson Klemencic Associates
Construction Manager – Gilbane
Program Manager – Parsons Brinkerhoff Aviation

*Terminal B*

Design Builder – Hensel Phelps Construction Company
Architect – Fentress Architects
Structural – Magnusson Klemencic Associates

*Terry Palmer, P.E., is a Principal at Magnusson Klemencic Associates (MKA), and head of the firm's Aviation Specialist Group. He is also co-author of the TSA's newest blast-resistant provisions in the "Recommended Security Guidelines for Airport Planning, Design & Construction" published in June 2006. Terry may be reached at* ***tpalmer@mka.com****.*

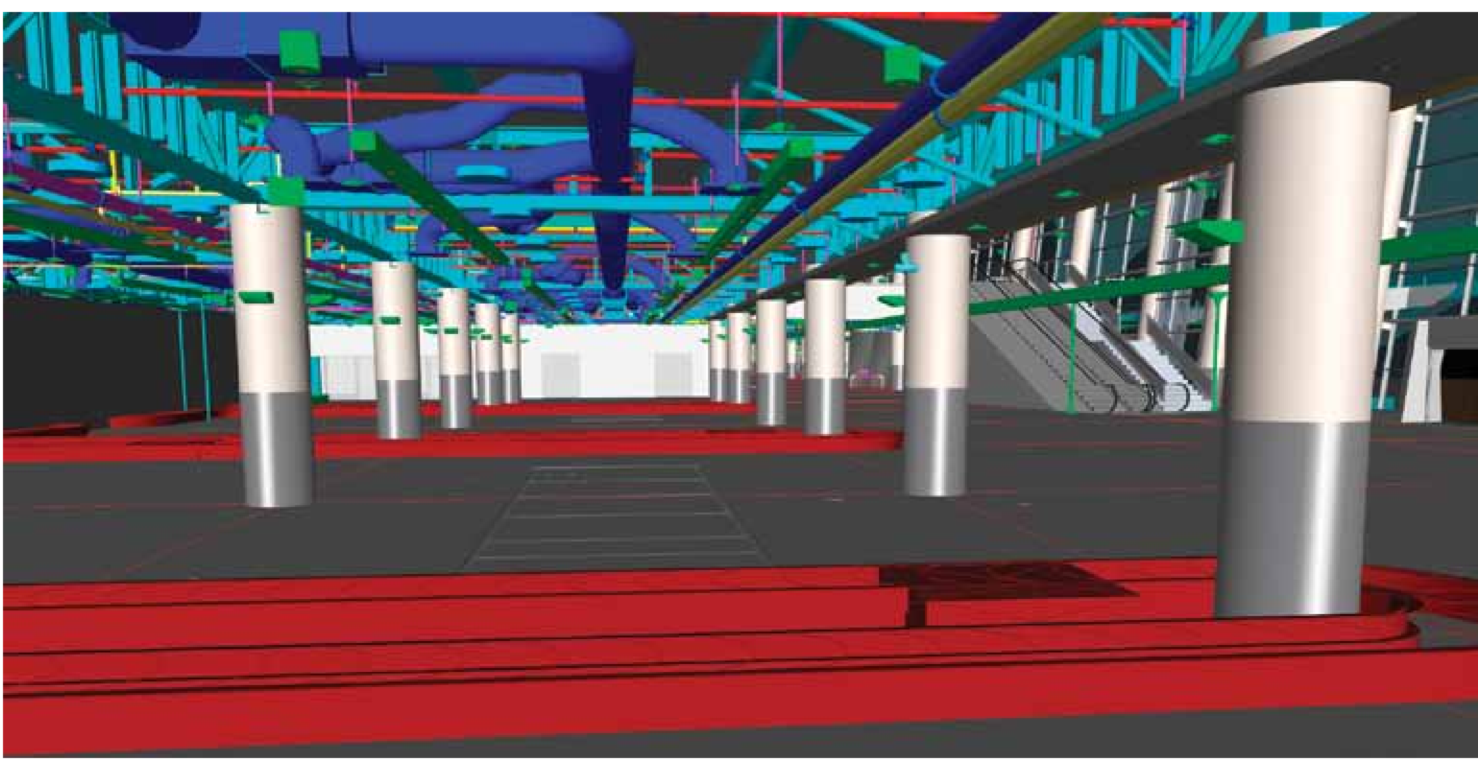

*Figure 5: A fully integrated Revit Building Information Model of Terminal B was used to minimize conflicts, speed construction, and document existing conditions for future operations. Courtesy of Hensel Phelps.*