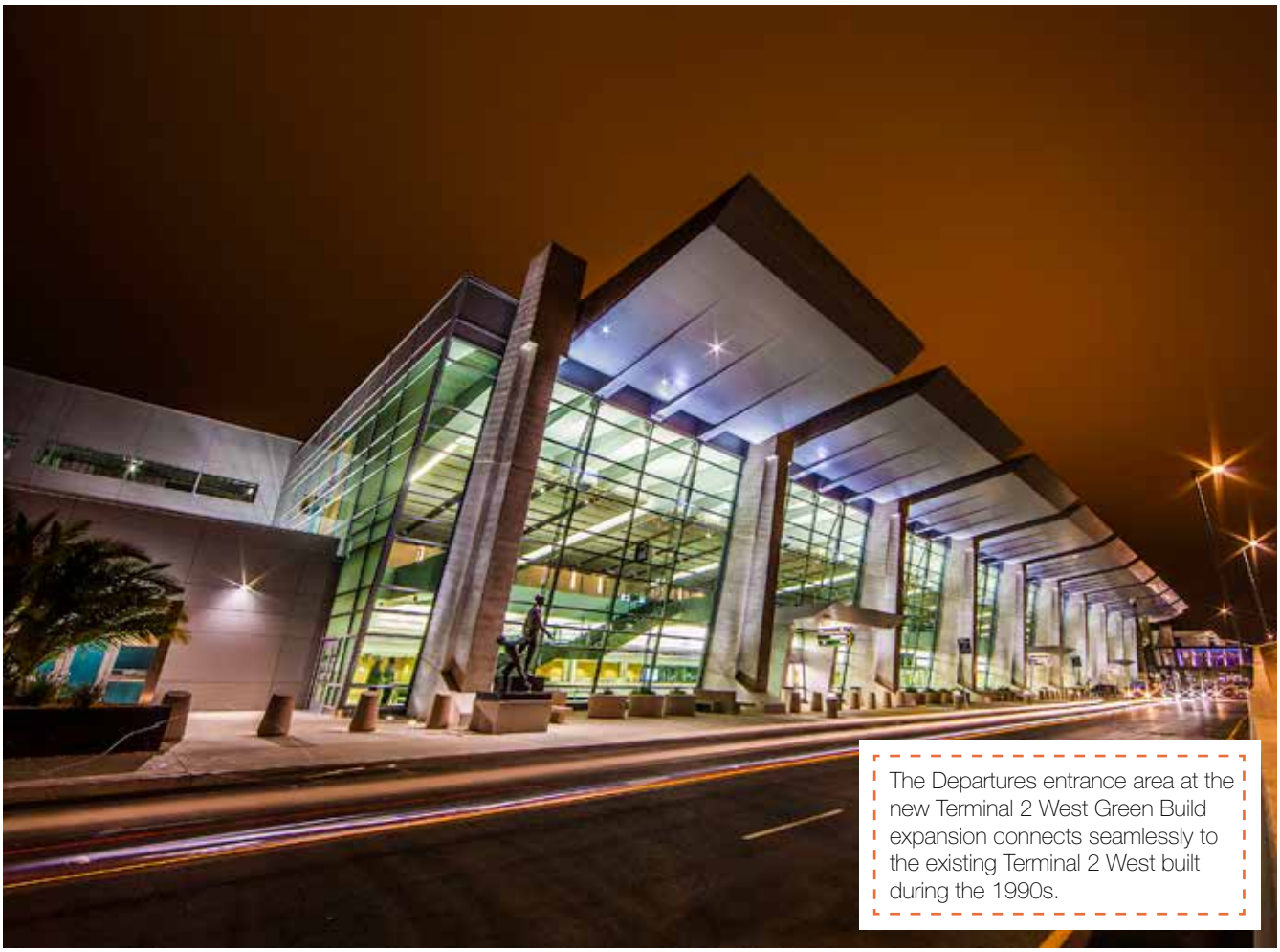
San Diego International Airport Terminal 2 West Expansion

San Diego, Calif.



The Departures entrance area at the new Terminal 2 West Green Build expansion connects seamlessly to the existing Terminal 2 West built during the 1990s.

Project Team

Owner
San Diego County Regional Airport Authority (SDCRAA), San Diego, Calif.

Architects
HNTB Architects, Los Angeles, Calif.

Associate Architects
Tucker Sadler Architects, San Diego, Calif.

Structural Engineer
John A. Martin & Associates Inc., Los Angeles, Calif.

Associate Structural Engineers
Martin & Libby, San Diego, Calif.
Simon Wong Engineering, San Diego, Calif.

Design/Build Contractor
Turner, **PCL**, **Flatiron** joint venture

Steel Fabricator
Schuff Steel, San Diego, CA

Photos and content provided by John A. Martin & Associates Inc.

Streamlined Structural Steel Design Enables Airport Terminal Expansion to Take Wing in San Diego

Designers use steel's design flexibility to achieve architectural goals and meet critical seismic demands without requiring expensive upgrades to the existing structure.

The baggage claim area gleams brightly with unobstructed public space through which travelers can flow efficiently. Team collaboration was key to improving on the master plan so that the terminal's expansion blended with the existing structure without requiring major seismic upgrades.

Terminal 2 West at San Diego International Airport was designed and constructed during the early 1990s. The design was in-progress when the 1994 Northridge Earthquake occurred. Substantial investigations by industry experts of structural systems that failed as a result of that earthquake eventually led to code modifications, particularly with regard to steel moment frame connections. A period of time elapsed before the new code requirements were developed and adopted by building officials. The design of Terminal 2 West continued prior to knowing the eventual code changes. However, the design team met with the San Diego building officials and negotiated reasonable design considerations in advance of the future code changes.

A future expansion to the west was part of the original master plan. The future expansion would essentially mirror the original Terminal 2 West, but would be separated via a longitudinal seismic separation joint and double row of columns throughout the passenger concourse area. It was anticipated that there would be substantial post-Northridge code modifications prior to designing the west expansion. Pre-planning a seismic separation joint was strategic in that it would mitigate the seismic influence of the future expansion on the existing building regardless of future code changes. However, a separation joint with a double row of columns would diminish the passenger experience, create maintenance issues, and inhibit the preferred architectural expressions.

Starting in 2009, the structural team developed a solution to eliminate the longitudinal seismic separation joint and the second row of columns. The solution enabled the new expansion to be attached to the existing terminal without the joint, using lateral resistance systems that were strategically positioned and proportioned such that a code-mandated seismic upgrade of the existing building would be avoided. This was accomplished even though the new building addition was one story taller than was initially envisioned by the master plan.

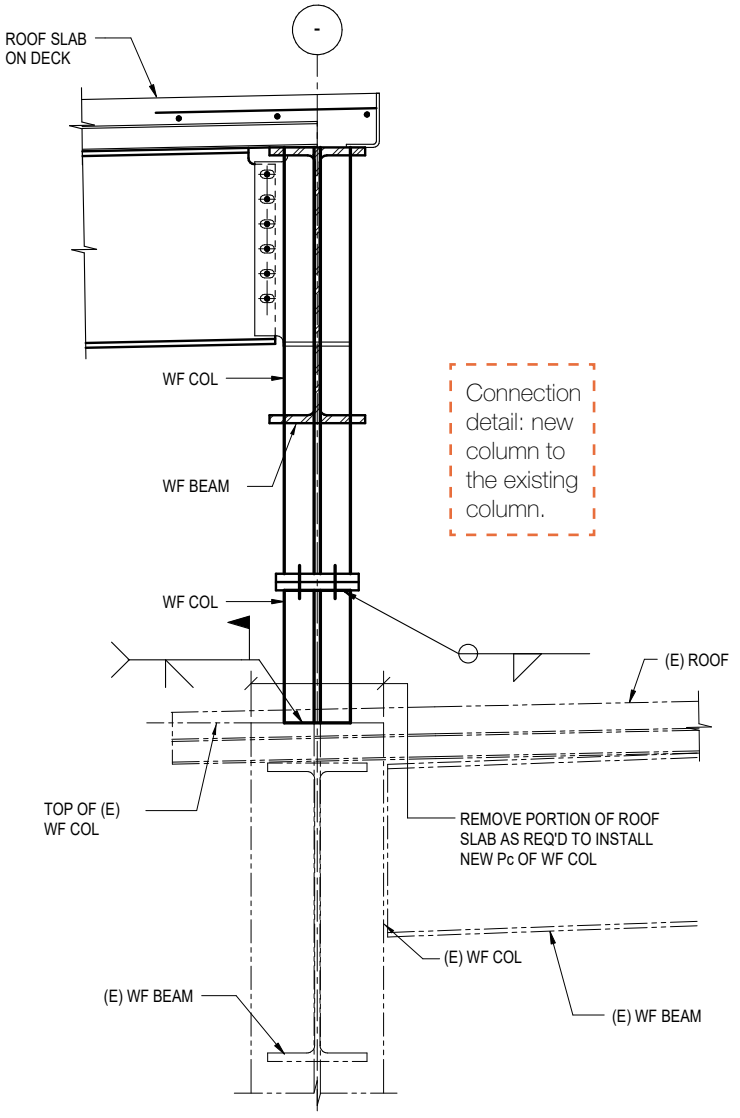
How it was done

Chapter 34 in the 2007 *International Building Code* (*IBC*) provides threshold limits beyond which code-mandated seismic upgrade is required for renovated buildings. Seismic upgrades are required whenever the seismic effects on portions of the existing lateral resistance system increase by more than 10 percent whenever the renovations are considered.

The design team developed structural schemes using strategically placed special moment resisting steel frames of sufficient stiffness to limit the seismic effects upon the existing building to less than 10 percent.

Three dimensional dynamic analyses of the combined buildings were performed and compared to the analytical results of the original unmodified building considering current code prescribed seismic loading. This enabled evaluation against the 10 percent threshold code limit. The current design team was able to evaluate any reserve capacities that were inherently available as a result of the design and detailing concepts that were negotiated during the 1990s between the structural engineers for the original building and the building officials.

The evaluations of the existing framing were performed with respect to current code requirements. Because the original building did not anticipate the future expansion to be connected to the original framing, the existing edge framing along the proposed seismic separation joint was not designed to support additional framing. The new expansion mitigated the need for structural upgrades of the existing edge members by framing around members that would have needed structural upgrades. Field investigations were performed to compare the existing edge framing to the as-built record drawings. There were substantial deviations; however, the design team mitigated adverse effects on the



Connection detail: new column to the existing column.

Passenger experience is enhanced throughout the West expansion because designers strategically positioned and proportioned its lateral resistance system so that a previously planned seismic joint and double rows of columns could be eliminated.

Collaboration essential to 2 West's design solution

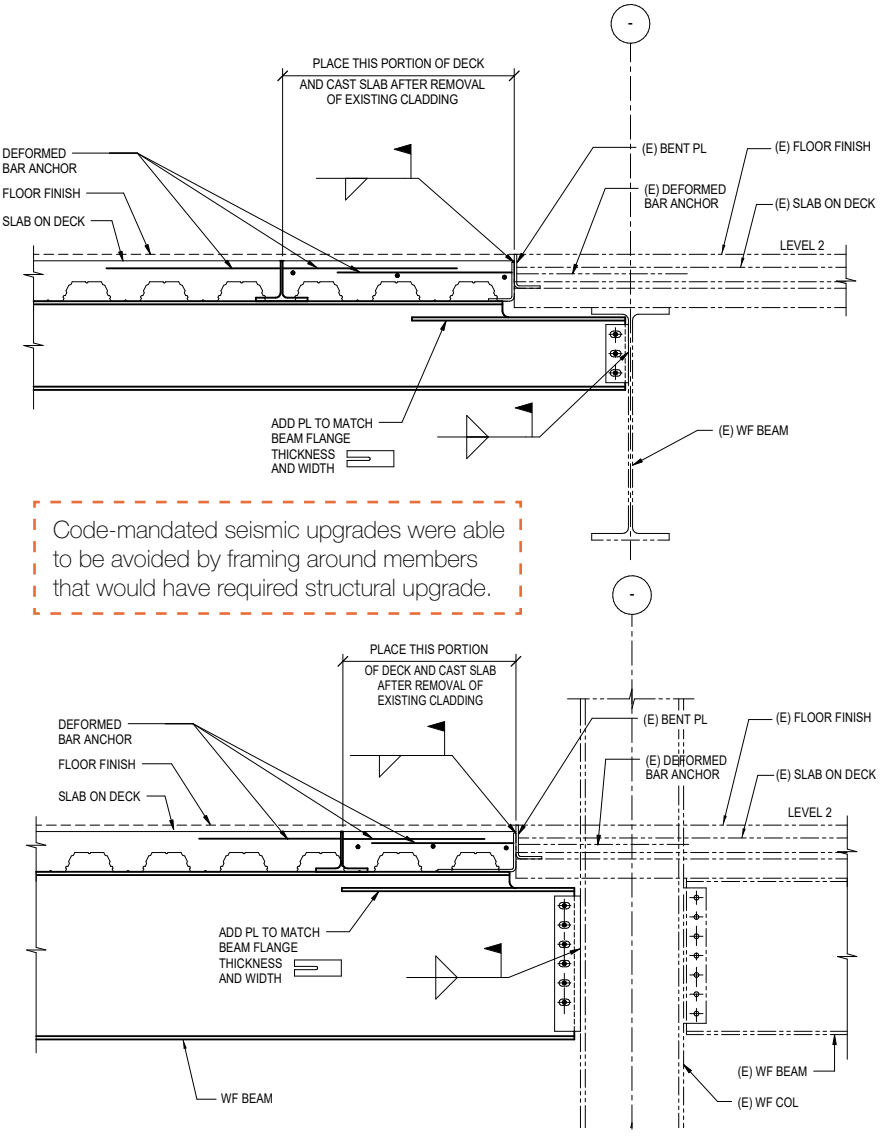
The design-build terminal expansion consists of 430,000 square feet of new public and non-public areas, providing 10 additional contact aircraft gates.

Numerous project team members worked together strategically for the expansion of the T2 West terminal, including John A. Martin & Associates, Inc. (JAMA) architect HNTB, the joint-venture contractor partnership of Turner, PCL, and Flatiron, the San Diego County Regional Airport Authority, local associate structural engineering firms of Martin & Libby and Simon Wong Engineering, San Diego building officials, and the structural steel fabrication and erection team.

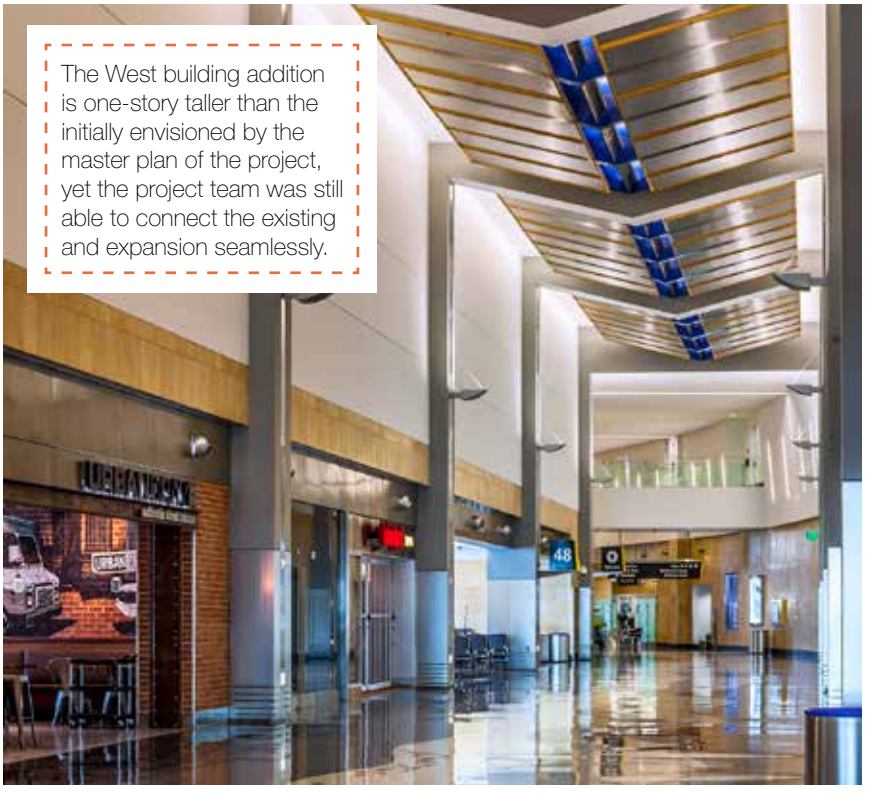
JAMA worked collaboratively with the contractor from the conceptual stages of the project through design and construction. The interaction included in-depth analysis and discussion of various structural solutions; their responsiveness to the architecture and the airport functions; their cost effectiveness considering prevailing market conditions; and their ability to optimize or accelerate the construction schedule.

The design concept turned into reality as a result of continuous collaboration between JAMA, the airport authority, the contractor, the local associate structural engineering firms and the building officials.

The structural design came in under budget; was approved more quickly than traditionally occurs in San Diego; and was constructed within an aggressive schedule. The original program documents included in the RFP specified a seismic joint between the existing concourse and the new concourse. A creative solution was conceptualized and designed to enable the elimination of the seismic joint without requiring code-mandated seismic upgrade of the existing building. And the project's LEED Platinum certification made it the first airport project to attain such a rating.



Code-mandated seismic upgrades were able to be avoided by framing around members that would have required structural upgrade.



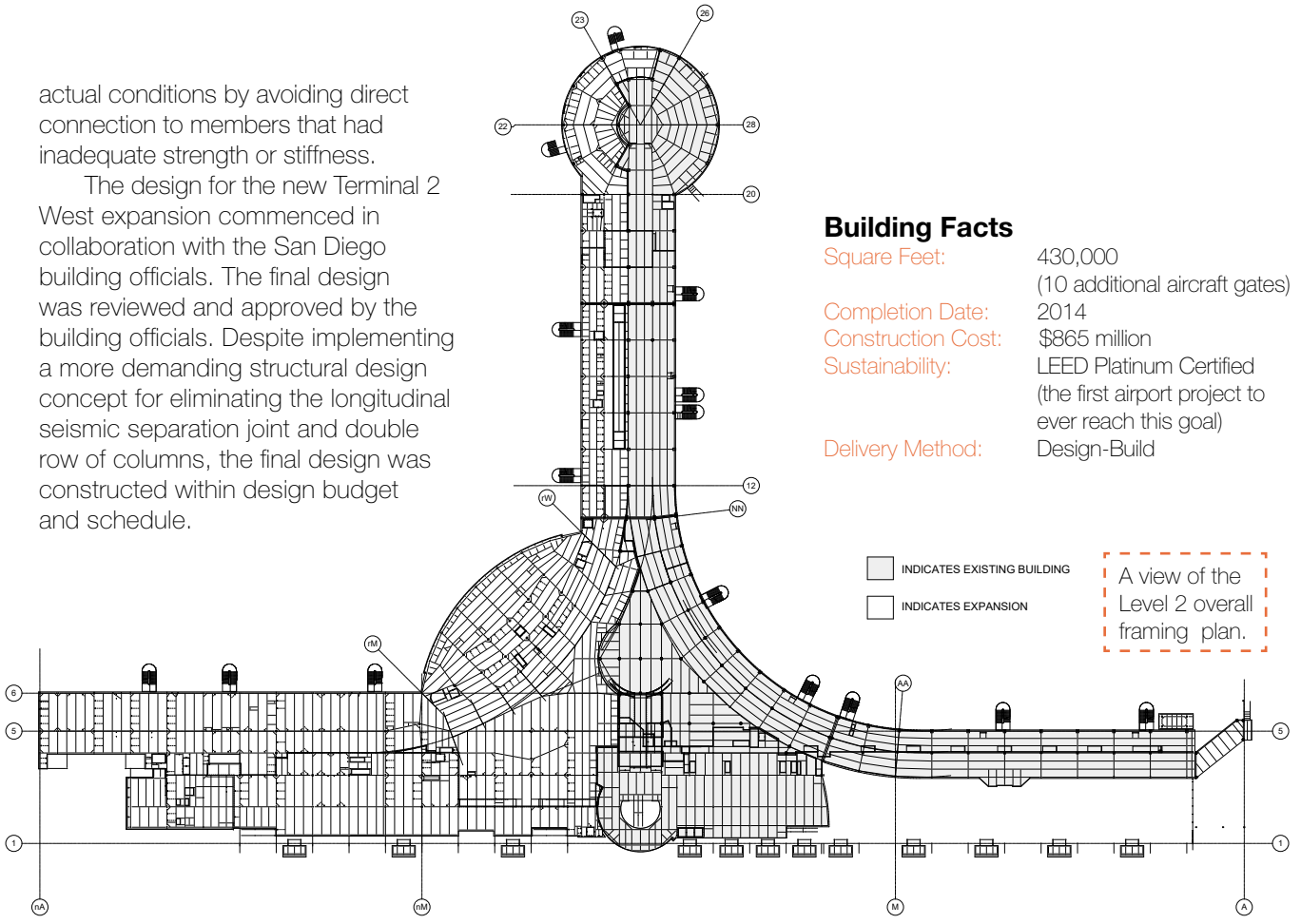
The West building addition is one-story taller than the initially envisioned by the master plan of the project, yet the project team was still able to connect the existing and expansion seamlessly.

actual conditions by avoiding direct connection to members that had inadequate strength or stiffness.

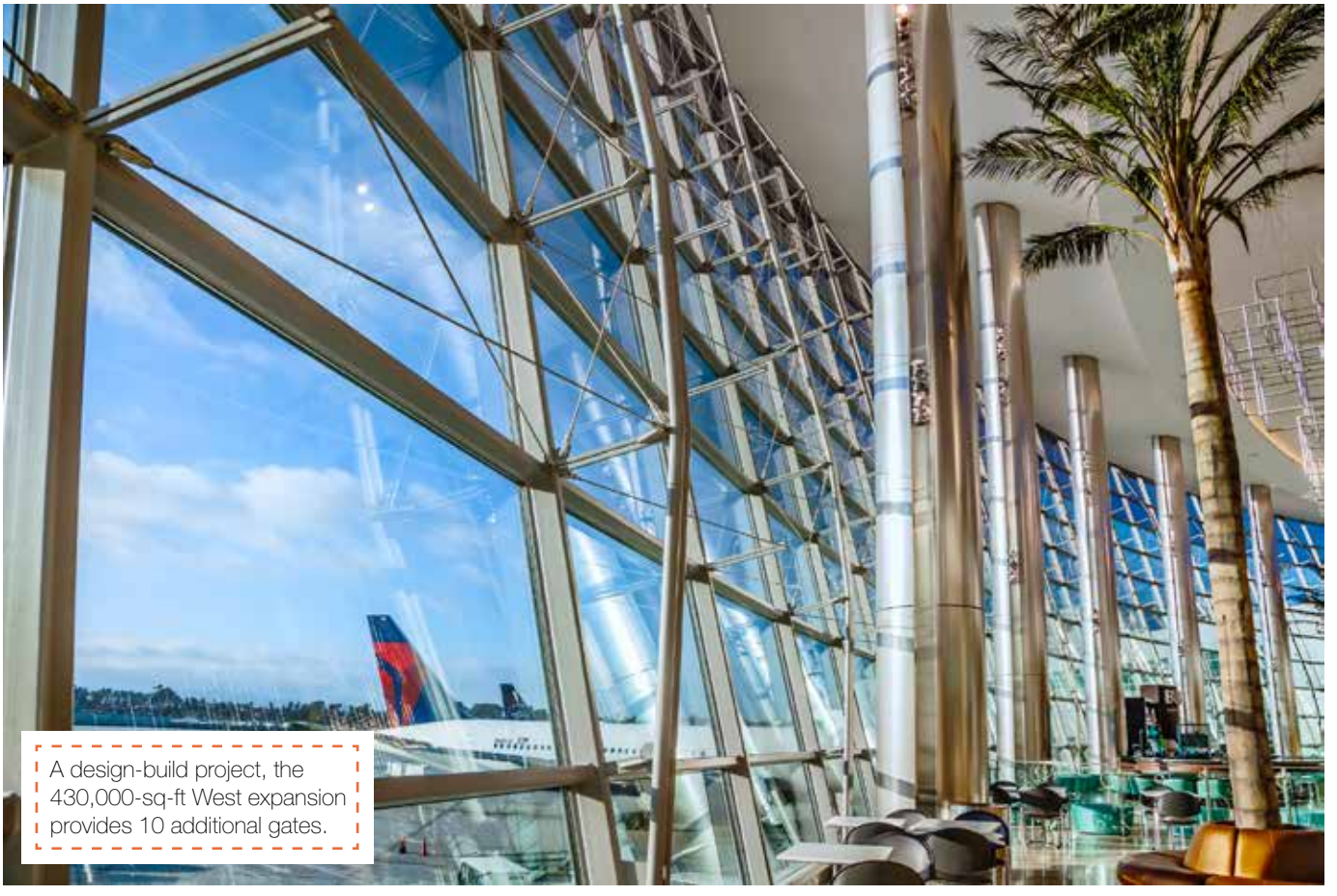
The design for the new Terminal 2 West expansion commenced in collaboration with the San Diego building officials. The final design was reviewed and approved by the building officials. Despite implementing a more demanding structural design concept for eliminating the longitudinal seismic separation joint and double row of columns, the final design was constructed within design budget and schedule.

Building Facts

Square Feet:	430,000 (10 additional aircraft gates)
Completion Date:	2014
Construction Cost:	$865 million
Sustainability:	LEED Platinum Certified (the first airport project to ever reach this goal)
Delivery Method:	Design-Build



A view of the Level 2 overall framing plan.



A design-build project, the 430,000-sq-ft West expansion provides 10 additional gates.

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