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INTERNATIONAL TERMINAL BUILDING (ITB) at San Francisco International Airport

San Francisco, California

Peter L. Lee, S.E.

Design Concept

The new International Terminal Building (ITB) at San Francisco International Airport is the centerpiece of the airport's $2.6 billion expansion and modernization program. Its completion greatly increases the efficiency and capacity of all international arrivals and departures with 26 new gates and maintains San Francisco's standing as America's gateway to the Pacific Rim. The roof structure and main façade of the Terminal, visible from approaching roadways and the air, give the entire Airport a visual cohesiveness and an iconic sense of identity, both as a major public facility and as the city's front door to the world. The genesis of the

design is found in both the structural requirements generated by the site and the desire to create a symbolically appropriate form for the Airport. The form of the building reflects the need to span existing entry and exit roadways that run under the Terminal.

Main Terminal & Departures Hall

The main roof structure consists of two sets of balanced cantilever trusses supporting a central third set of trusses linked together creating a continuous wing-like form. The system of trusses up to 29′ deep spans 380′ at its center and 160′ at each end cantilever with an overall length of 860′. The Main Terminal's glass-enclosed "great hall," 705′ long, 210′ wide and up to 83′ high, creates a dramatic departure point for travelers, but does so with an economy of form and material. The exposed steel trusses utilize state-of-the-art steel tubular T-Y-K joint detailing and fabrication techniques of trusses sitting on spherical ball-joints atop 20 cantilevered concrete filled steel box columns, while the center spans are interconnected by "cast steel" pinned joint assemblies.

Construction

At a total construction cost of $840 million, the Main ITB consists of an integrated and innovative creative solution to complex project requirements and constraints. It was a significant accomplishment to keep these roadways operational during construction. Framed in structural steel, the structure includes 1.8 million sq. ft. of framed steel area (25,200 tons), 172,000 sq. ft. of exposed trussed steel roof (4,040 tons including main roof cantilevered box columns) and 760 tons of exposed steel at Main ITB departure's level window walls and entrance canopy. Roof trusses were fully assembled in the shop and then disassembled into some 35 major pieces to minimize field connections and shipped directly to the site on barges. Once completed, trusses were jacked into position and the pinned in place.

Seismic Performance

The airport's seismic performance goal of continued operation following a major earthquake is achieved for the Main ITB using a strategy of seismic isolation. The isolation system utilizes 267 friction-pendulum "cast steel" base isolators installed at the foot of each structural column, which allow up to 20″ lateral displacement. The building's superstructure is separated from its foundation by a mechanism that allows the ground to move relative to the building. The design allows the weight of the building itself to provide inertia and damping, so that the seismic energy is dissipated rather than absorbed by the structure. The system reduces earthquake force demands on the building by 70%. With more than 1.2 million sq. ft. of floor space and more than 22 million cubic feet of interior volume, the terminal is the largest base-isolated building in the world.

Analysis & Design

The project was analyzed, designed and detailed as an "essential facility" using site-specific response spectra generated for the soft Bay-mud soil site. The steel frame superstructure and main roof were designed to remain essentially elastic under the design basis earthquake with minimum ductility demands under the upper bound 1,000-year earthquake. The irregularities in plan and elevation for the new international terminal structure imposed great challenges for analysis and design. The arrival and departure levels constitute a huge platform for the superstructure, where twenty cantilever box columns support five main roof trusses above the departure level along with a three-story office block that is completely independent of the

main roof. Analysis and design was performed to study the interactions among the three structural components and the behavior of the base isolation system.

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San Francisco International Airport
San Francisco, CA

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Buckley & Company (JV)
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FABRICATORS:
The Herrick Corporation (AISC member)
Pleasanton, CA
South Shoulder, 2/3 of
isolated area & roof infill

PDM Strocal (AISC member)
Stockton, CA
North Shoulder and 1/2
of isolated area

Nesco-XKT
Mare Island, CA
Roof Trusses

Canron
Vancouver, Canada
Curtainwall

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The Herrick Corporation (AISC member)
Pleasanton, CA
South Shoulder & Isolated Area
PDM Strocal (AISC & NEA member)
Stockton, CA
North Shoulder

DETAILERS:
Cal-West (NISD member)
Pleasaton, CA
South Milestone 1

Baseline (NISD member)
Toronto, Canada
South Milestone 2

Candraft (NISD member)
Vancouver, Canada
North Milestone 1 & 2

Hargrave (NISD member)
Dallas, TX
Areas 8 & 10

Lannon & Associates
Grapevine, TX
Area 9

NC Engineering (NISD member)
Vancouver, Canada
Roof & Curtainwall

SOFTWARE:
SAP90, ETABS (v6.0),
and 3DBASIS-ME