Kansai International Airport Terminal

Bay of Osaka, Japan 1988-1994

Case Study Team:
Jill Atkinson      Jenny Krenek
Sudeep Bile       David McMillin
Pamela Hile

Renzo Piano Building Workshop - Architects in association with Nikken Sekkei Ltd

Ove Arup & Partners - Structural Engineers
In the late 1960s, the Kansai Region in Japan realized an economic need for a new airport near the Bay of Osaka. Two decades passed before groundwork was laid for Kansai International Airport. To prevent noise pollution and allow for 24-hour a day operation officials chose to build an island in Osaka Bay on which to construct the passenger terminal and runways.

1987-1991: Island construction

Simultaneously a design competition was held, for which Renzo Piano Building Workshop (in collaboration with Ove Arup) won the commission.

Largest man-made island - 22,000,000 cubic meters of reclaimed land, 4 km x 1km in size.

Final cost of constructing both island and passenger terminal was $14 billion US dollars.

Longest building in the world - 1.7 kilometers

Since 1987 the island has subsided approximately 10 meters. Since 2002 the rate of submergence has decreased.

Hit by the Kobe Earthquake of 1995 and the terminal sustained no damage.
Diagram of the toroid which is 20 miles in diameter, however only a very small portion of the toroid is used for the airport.

Concept sketch by Renzo Piano
The toroid creates a space that is both high in the center portion and low at the ends in order to have unobstructed views of all airplanes and the runway from the control tower.
Another roof form generating idea was the desire to condition the passenger terminal without a clutter of ductwork hanging from the exposed trusses. This was done by blowing a jet of air from the landside and let it be carried against a ceiling that would be shaped to follow the natural curve of the decelerating air. Huge scoop like ceilings entrain the blown jets of air across the space.
• Primary truss type is a Warren based, triangular three-dimensional truss
• Asymmetrically arched tracing the shape of the curvilinear roof above
• 18 trusses spanning 82.8 meters each
• Trusses placed 14.4 meters apart
- A continuous secondary structure spans across the primary trusses
- Built out of standard I-sections with traditional cross bracing
- Designed to absorb lateral forces generated by earthquakes
- Also helps restrict potential buckling of the primary trusses
- Gable ends of main terminal are double bow trusses
- Used to avoid complexity of joining a truss and glazing
Modeled Warren Truss Under Uniform Load
Force and Stress under Vertical Loading

Exaggerated deformation under Vertical Loading
STRUCTURAL LOADING

Force and Stress under Lateral Loading

Exaggerated deformation under Lateral Loading
Airside

- The Wing runs the entire 1.7 km span of the structure. This is the side that faces the sea, and therefore receives the blunt of the high force winds during storms.

- The wing has a separate structural system from the main terminal building. Here, the truss changes to a single tubular steel member supported by tension cables.
- A strong secondary system provides the shear support

- Connection detail between the primary structural system (tube) and the secondary structural system (rectangular grid)
The ground connection and the row of columns provide the vertical supports.

Connection Detail between the truss (left side) and the single tubular member (right).
CLADDING

- 82,000 Stainless steel tiles cover a double roof
- Each tile 1.8 x 0.6 meters and 10 kilograms
- Reasons for choosing a double roof
  - Reflectivity protects inner roof
  - Ease of installation of inner roof
  - Drainage keeps outer roof in good condition
- Tiles flex and lift in their middle to combat uplift
GLAZING

- Each pane of glass treated as an individual unit
- Each panel 3.6 x .6 meters
- Follows the same geometry of the roof
EXPANSION JOINTS

- Design of cladding and glazing must consider movement
- Expansion joints used to absorb movement
- Gaps 450-600 millimeters wide placed every 150-200 meters
- Rubber elements used to provide weatherproofing
- Built on a man-made island
- Stabilized alluvial clay with one million sand piles and a meter thick layer of sand
- Construction upon diluvial clay is unknown
- The structure needs to sink at the same rate as the island
- 360,000 tons of iron ore below foundation replaced excavated soil
- Foundation consists of 900 pillars
- Jack system with plates keeps the pillars level
WORKS CITED


PHOTOGRAPH REFERENCES

•www.rpbw.com
  Slide: 1, 3, 4, 5, 6 (left), 8, 19 (right), 21 (left)
•http://en.wikipedia.org/wiki/Kansai_International_Airport
  Slide: 2,
•Renzo Piano Building Workshop, Complete Works Volume III
  Slide: 9, 10, 18, 19 (left), 21 (right), 22, 23, 24,
•http://cuckoo.com/daniel/pictures/japan2002kix/oap
  Slide: 6 (right), 11, 12, 13,
•http://courses.arch.hku.hk/precedent/1996/kansai
  Slide: 14, 15, 16,
•www.nouvelle-vie.com
  Slide: 20
•Passenger Architecture
  Slide: 25, 26
•www.iadmfr.org/congresses/osaka/images3-osaka.htm
  Slide: 27