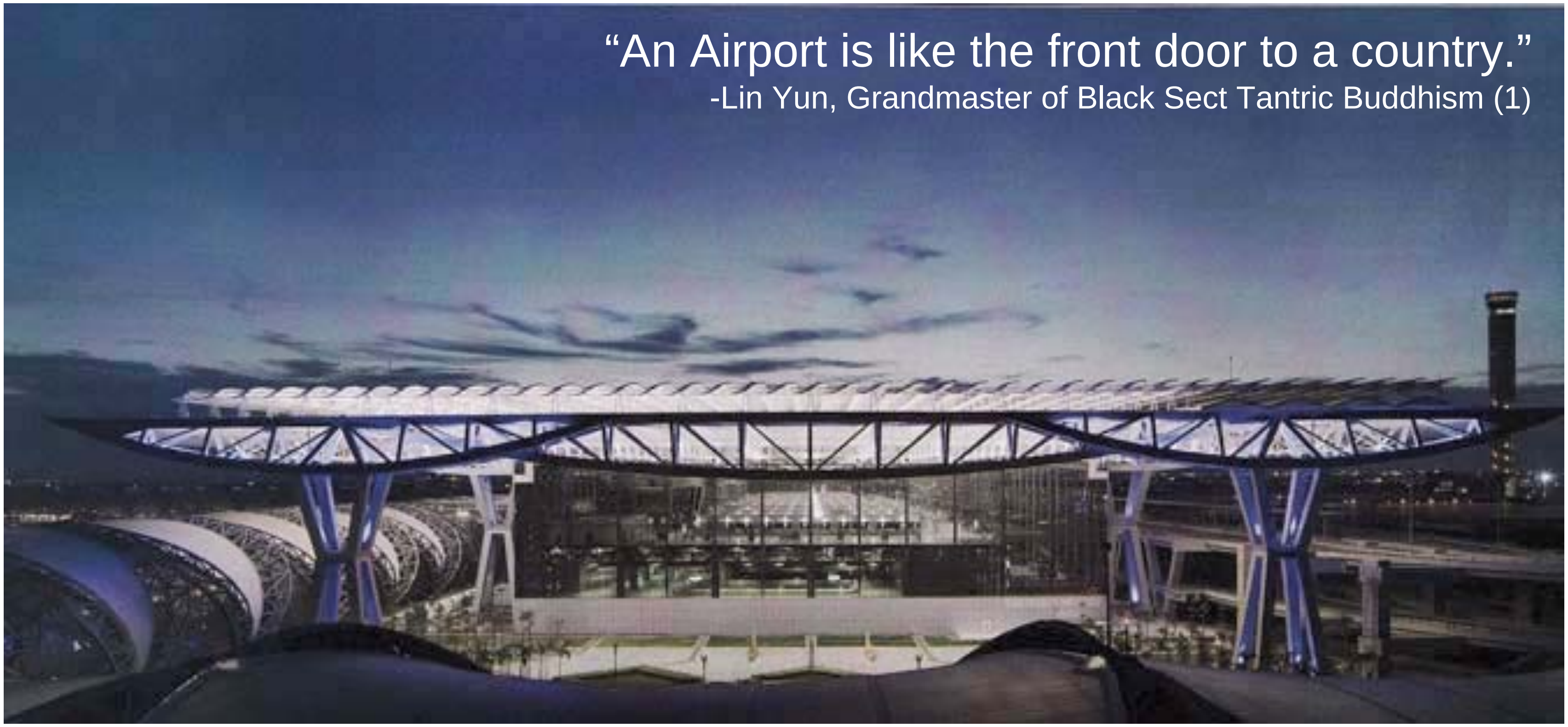
SUVARNABHUMI AIRPORT

STEPHANIE GEPFORD

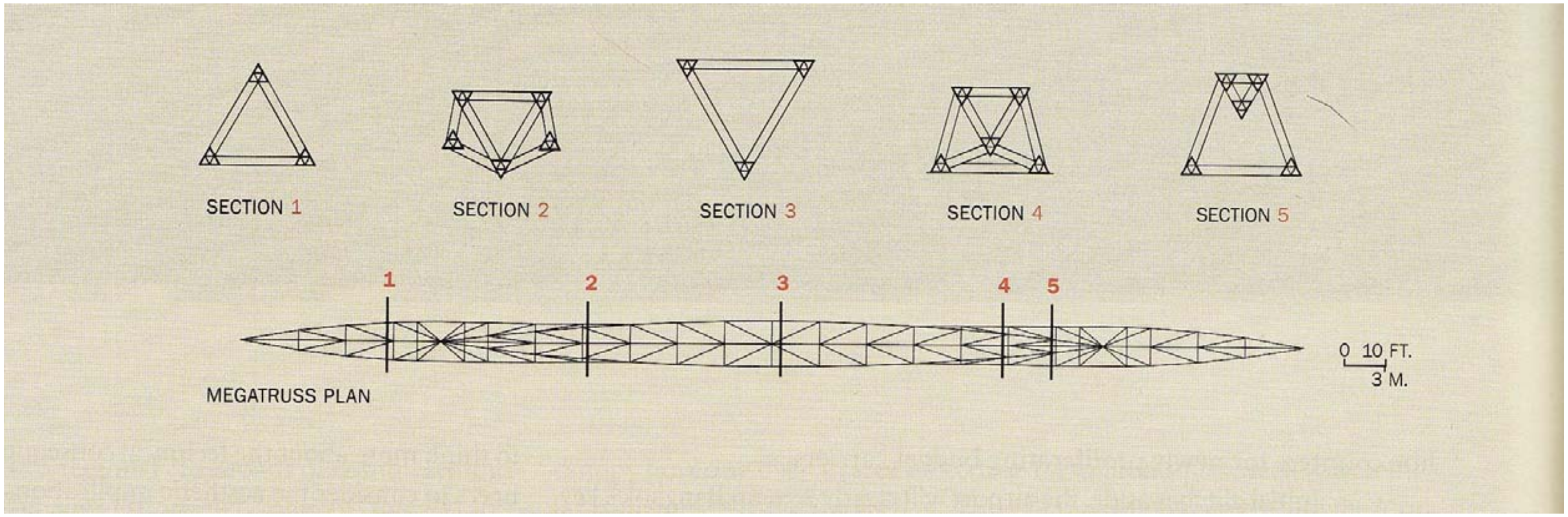


The Suvarnabhumi Airport (pronounced **Soo-wana-poon**[2]) has become Thailand’s international “glass portal[3]”. Suvarnabhumi, translated as “Golden Land[2],” has taken 46 yrs to plan and execute[3]. Sited to serve Thailand’s capital city, Bangkok, the former Cobra Swamp[3] began to settle nearly 4 months after construction, causing over 100 cracks in the taxiways and runways[4]. The almost immediate appearance of the cracks came as a shock, considering Suvarnabhumi is said to be the largest public works project in Thailand’s history[2], with a price tag of over 4 billion[5]. Perhaps Suvarnabhumi’s saving grace is the innovative design for both the Main Terminal and its neighboring concourses, a collaborative effort between the Chicago based architecture firm Murphy/Jahn and Stuttgart engineers Werner Sobek and Matthias Schuler. After being awarded the project in an international competition held in 1994, principle architect Helmut Jahn and his partnering engineers quickly forged an interdisciplinary relationship recognized today as *Archi-Neering*[6].

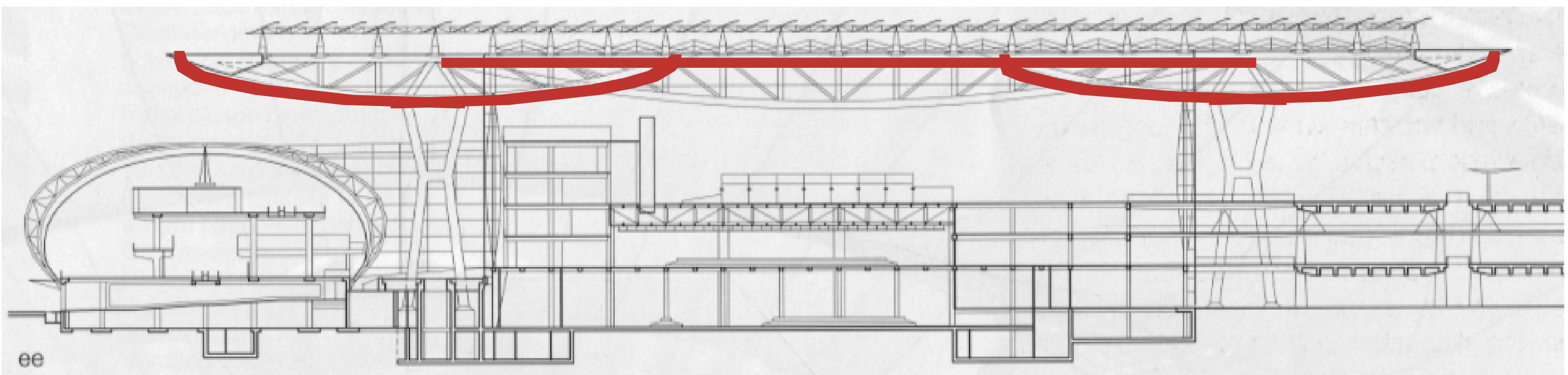
Conceptually, the repetitive structural elements and bays used in the construction of the airport appear to recall water, as these reoccurring elements are placed in wavelike, undulating rows for the concourses. The design for the Main Terminal also seems to reinforce this idea, as its cantilevered roof gives the appearance that it is “floating” over the concourse beneath[6]. In a sense, the overall design could be thought to express the former essence of the site, from which the water had to be drained before construction could begin. The design’s perceived association with water was later deemed negative by a Feng Shui consultant who believed the water like forms were inappropriate for the site and thus partially responsible for the negative events that followed the airports opening[1].

The exquisite integration of the structural forms into the overall aesthetic can be attributed to the various designers commitment to respect one another’s initiatives. Helmut Jahn personally describes this phenomenon, known as Archi-Neering, as when “the architect thinks about the technical consequences of the forms he designs and the engineers consider the aesthetic implications of their concepts and decisions[6,7]”

When these methods are applied to Suvarnabhumi, the result is structure in its most efficient form. In fact, the function of each individual truss is expressed explicitly in its form, and thus "structurally rationalist" in nature. The eight composite 2,710-ton trusses supporting the canopy of the Main Terminal are "essentially diagrams of the bending moments acting on them, with the greatest depth at midspan and over the supports[6]." The differing cross sections can be seen below.



These mega-trusses are basically composed of three smaller trusses joined together via pin connections: the middle truss (acting similarly to a drop-in beam), flanked by two cantilevered trusses. The character of the outer and inner trusses forming the mega-truss is distinct, since the outer and inner trusses address compression inversely to one another. Whereas the **top** of the middle truss is formed by two chords to account for the compression of the roof structure, the **bottom** of the cantilevered trusses is formed by two chords, sense the concentration of compression reverses when the outer-trusses are cantilevered (the location of the double chords in compression are indicated in red in the section below).

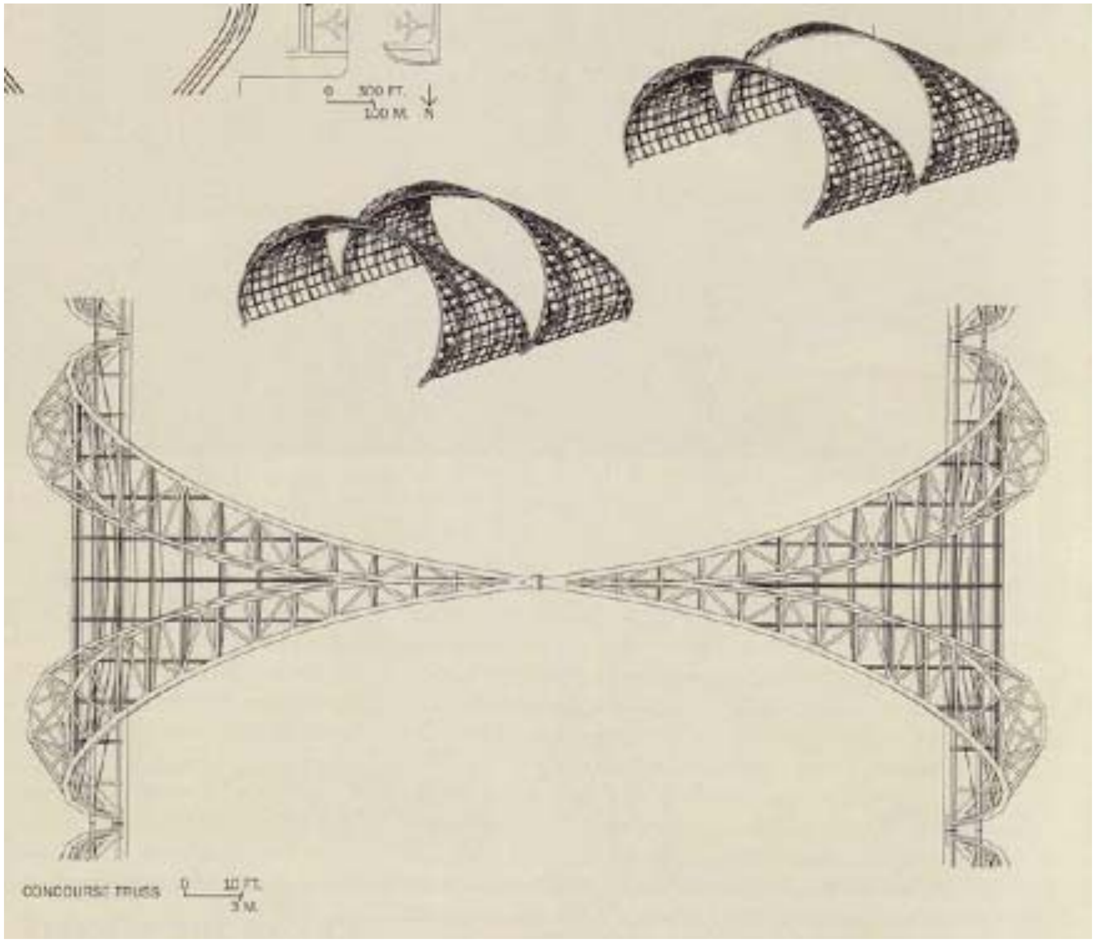


The use of two chords to combat compression provides additional benefits beyond mere reinforcement. By spreading the chords out to either side of the neutral axis, the Moment of Inertia is increased (increasing the stiffness of the cross section). In addition, the resultant triangulation of the cross section creates an opportunity for the trusses to effectively interlock into one mega-truss
(this connection is shown above).

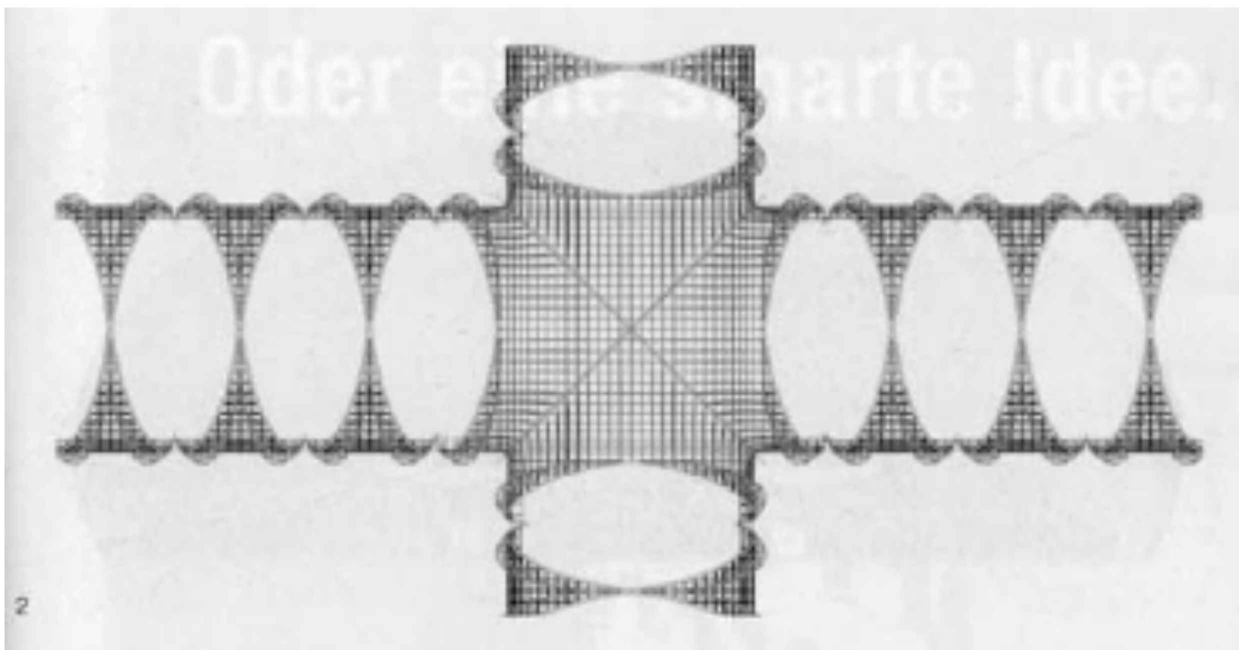
A rather large vertical support is needed to transfer the load from the mega-trusses to the ground. This column, as shown above, is a rigid frame. The rigid frame is fixed at the bottom where it meets the ground and at the top where it supports the mega-trusses. Due to the fixed connections, the column develops an inflection point. A pin connection is then placed where the inflection point occurs, which in turn reduces the moment generated.

Ultimately, the use of the mega-truss allows for very large spans within the Main Terminal, reducing the amount of columns needed and opening up the floor plan.

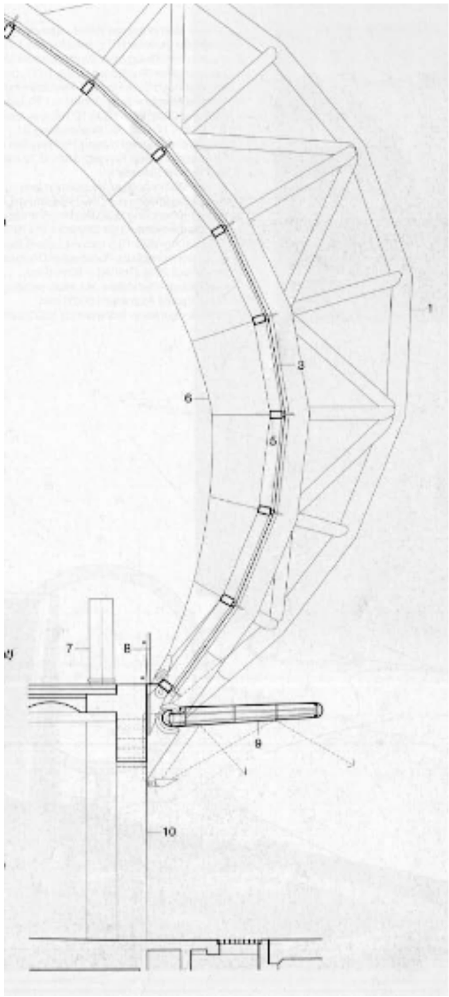
An equally efficient structural system is applied to the Airport's concourses. The engineers have developed these trusses in the form of an arch: one of the most efficient structural forms because it typically acts purely in compression. The gradual inward curvature of the five-point trusses shown below is used to combat the outward thrust exerted by the resultant arch.

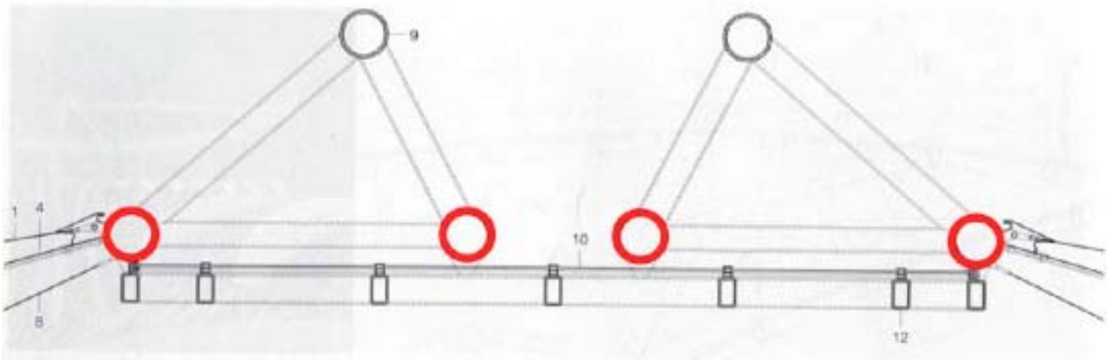


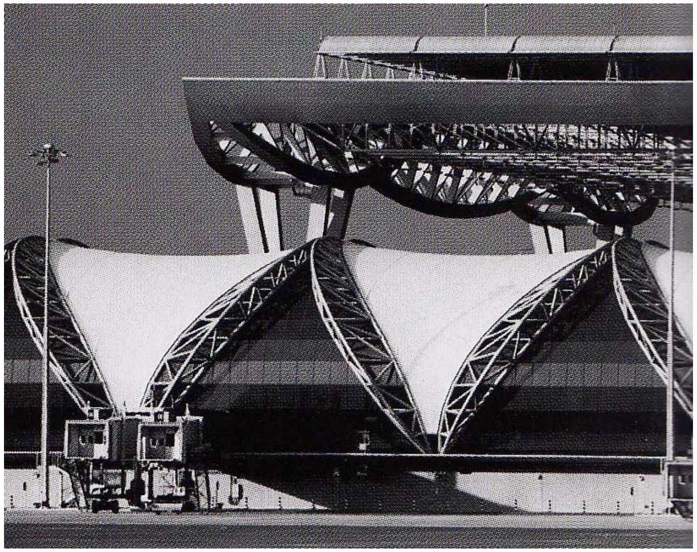
A second feature of the five-point truss is the gradual increase in lateral bracing in proximity to the supports. This gradual increase in material and breadth helps to spread the load across a larger surface area when transferring the load to the supports below. In other words, each side of the five-point truss acts as a triangle, beginning at the tip (which connects the two sides of the truss at the highest elevation of the “arch”), down to the base (which connects the five-point truss to the supports). The roof elevation exhibiting this triangulation of the load transfer can be seen below.



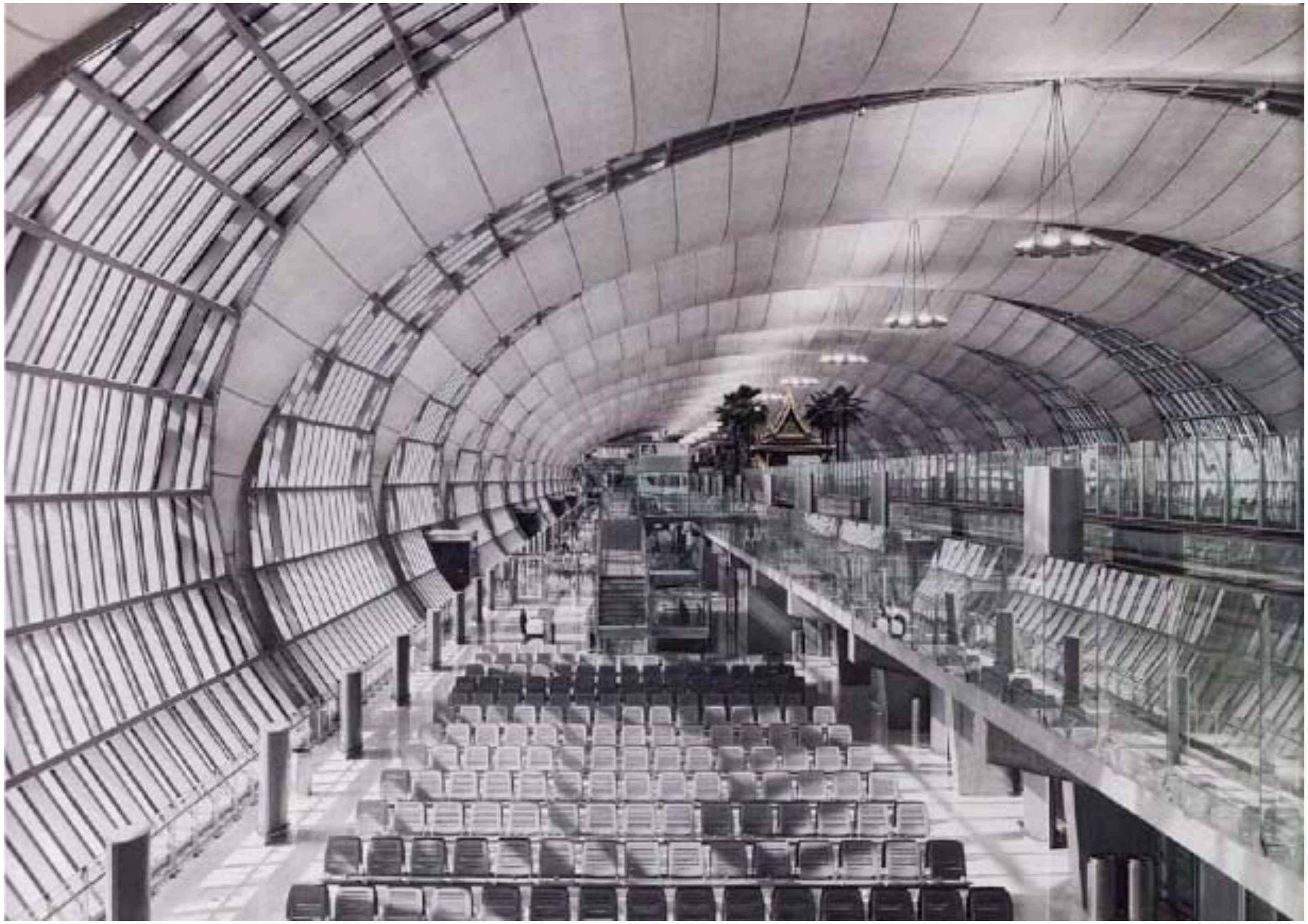
As seen before in the Main Terminal, the bottom chords are doubled in the five-point truss to potentially account for the compression in the arch (shown in red in the cross section below).



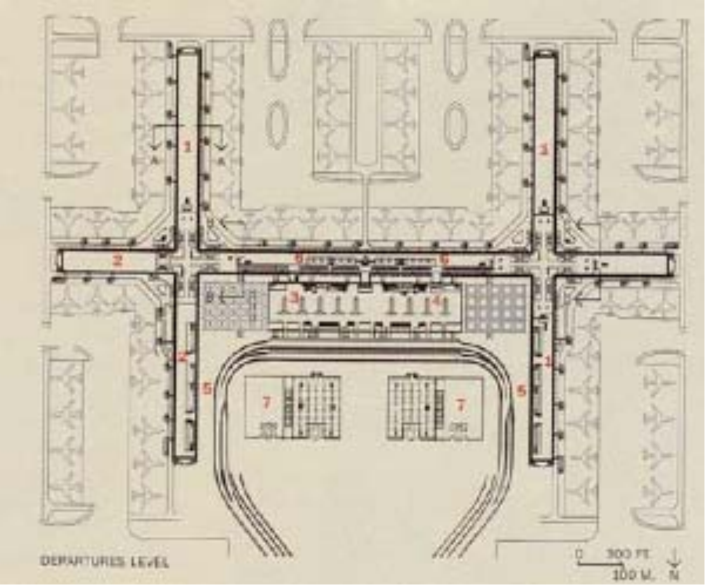




Though a different structural system from that used in the Main Terminal, the five-point truss achieves the same end: an open floor plan devoid of columns.



One should not be fooled by the apparent simplicity of Suvarnabhumi’s floor plan (shown right). Rather, the Suvarnabhumi Airport is a dynamic structure with trusses of varying cross sections and composite constructions that effectively fuse design and structure.



Footnotes.

1. Feng Shui for Fliers. (Global Advisor; Time Traveler). John Krich. *Time International (Asia Edition)* 169. 22 (June 11, 2007): p53.

2. Stuck at the Gate. *Asiamoney.* 18. 10 (November 2006): p92.

3. Rise of the Aerotropolis. Greg Lindsay. *Fast Company.* 107 (July/August 2006): p76-85.

4. Runway Cracks Highlight Thailand's New Hub Woes. *ENR: Engineering News-Record*. 258. 13 (April 2, 2007): p20.

5. Bangkok's Troubled Airport. *Air Transportation World*. 44. 4 (April 2007)

6. Suvarnabhumi Airport, *Bangkok*. John Morris Dixon. *Architectural Record*. (August 2007): p108-117.

7. Suvarnabhumi International Airport, Bangkok. (Structure and Form-Finding; Innovative Climate Concept; Passenger Terminal Complex; Engineering, Manufacturing and Installing the Membrane Roof) *Details*. 46. 7-8 (July-August 2006) p810-825.

Bibliography.

1. Bangkok's Troubled Airport. *Air Transportation World*. 44. 4 (April 2007)

2. Feng Shui for Fliers. (Global Advisor; Time Traveler). John Krich. *Time International (Asia Edition)* 169. 22 (June 11, 2007): p53.

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