
# Houston's Hobby Airport Gets New INTERNATIONAL UPGRADE

*By David W. Hillery, P.E., Matt Henderson, P.E. and Raxit Patel, P.E.*

*Figure 1. Structural framing at boarding pier.*

Houston's William P. Hobby Airport, named after the 27th Governor of Texas, was established in 1927 as a private airfield, with a main airport passenger terminal added in the 1950's. Hobby Airport was the primary commercial airport for the city until a new Houston Intercontinental Airport opened in 1969. After that, Hobby continued as Houston's secondary airport for domestic corporate and private airline service. A major addition to the terminal building was done in 1999, and a new construction project in 2015 added a Federal Inspection Services (FIS) terminal for international travelers.

It was mostly Southwest Airlines that made use of Hobby Airport in modern times and now Houston is its seventh-largest-focus city, so it was Southwest that constructed the international terminal there last year. The new terminal, as part of the Houston Airport System (HAS), allows Southwest Airlines to provide service to South America, Central America and Mexico. With 280,000 square feet of new space and five new boarding gates, Hobby Airport has become substantially more than it ever was.

Along with the new boarding gates, many features were included in the project. Renovation of the existing lobby, 16,000 square feet of additional concession space, reconfiguration of existing security screening with an increase from 8 to 14 checkpoint lanes, and relocation of office spaces also were accomplished in the new design. An expansion of the Baggage Handling System (BHS) was placed in a new tunnel, shared with other utilities connected to a new central utility plant. The project includes space to allow 800 arriving passengers to be processed through 16 passport inspection stations.

Construction costs totaled $156 million. That sum paid for such building features as terrazzo flooring, high ceilings, modern restrooms, a new moving walkway, more collaboration areas, large column-free spaces, and a very visible, tall and artistic exterior tree-like column.

The project structural design was done by Henderson + Rogers, Inc. (H+R) in Houston. They worked with the architectural firm of Corgan Associates, Inc. for Southwest Airlines and the HAS to provide the new facilities. There were a number of challenges in design and construction. While new structures were constructed and connections from the older to the newer features were being made, all airport-related traffic, concessions and other businesses had to be maintained without interruption.

## Structural Challenges Due to Existing Conditions

One challenge came in the form of an electrical room in the existing terminal building. This room had been providing essential daily services for critical airport operations. Relocating this electrical room without interruption of airport operations would be too costly. Therefore, the decision was made to keep the room intact rather

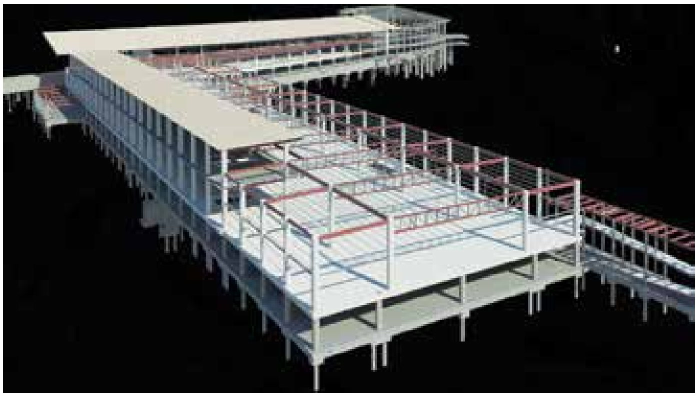

*Figure 2. BIM model – boarding pier.*

*Figure 3. BIM model – ticketing area.*

than move it. The challenge was twofold. First was the possibility of undermining the room's foundation during excavation of a nearby underground tunnel. So, a temporary soil retention system, 12 to 14 feet tall, was used (*Figure 6*). This system safely shored up the soil in the excavation, so the electrical room remained in constant use during construction.

Second, there was a need for the electrical room's roof to act as a concourse floor for the new terminal building. The roof could not simply be removed and replaced with a stronger system, because the structure supporting the roof was insufficient to support the new floor loads. The existing single-T precast roof system of the electrical room, built in 1962, was strengthened with additional rebar and structural lightweight concrete. Steel posts were added under the roof to reduce the effective span, and this brought its load carrying capacity up to 100 psf, as required by the *International Building Code*. All this was done while operations inside the room continued without interruption.

The new terminal building is connected to the existing terminal at both the second floor and the roof. New frame structures were strategically placed to minimize added loading to the existing members. Computer software, including RISA-3D, was used to model and analyze the existing building as well as the proposed structures. One result of the analysis was the decision to add new columns which pass through the existing roof down to supports on new cantilevered steel beams.

Another connection of the new to the existing structure is where framing for a new cantilevered canopy extended out from the existing 1950 structure. To achieve the desired height of the roof, existing steel columns received new extensions.

In addition to RISA-3D, other computer software used for advanced structural analysis and vigorous gravity and lateral design included ETABS and SAFE from Computers and Structures, Inc.

## Selection of Structural Systems and Their Benefits

The initial new building foundation was designed with straight-sided drilled piers. However, the design was modified after it was discovered that substantial money could be saved by using auger cast piles instead. Subsequent to a requested pile load test, the pile diameters were reduced from 24 to 18 inches. Incorporating changes could have affected the schedule of the project, so H+R redesigned the foundation and revised drawings in days rather than weeks for a savings in the overall cost of the foundation of approximately one million dollars.

The number of piles per column varied from one to four, and pile cap depth ranged from 36 to 42 inches. Four different pile lengths, 40, 50, 60 and 70 feet were incorporated in the design, depending on column locations and base reactions. The longer piles were needed under columns in close proximity to the tunnel and where they supported loads from large roof or floor areas.

An existing tunnel, approximately 1,000 feet long, accommodates the airport's Baggage Handling System and other utilities. A new tunnel was designed to run from the existing tunnel to the new international services, where customs requirements are more complex than for domestic flights. The new tunnel width varies from 22 to 48 feet along its length (*Figure 5*).

The new tunnel's foundation is a 12-inch thick, cast-in-place, steel-reinforced concrete slab thickened to 24 inches below walls. The walls are 12 inches thick and approximately 12 feet tall. The tunnel roof design considered heavy concentrated wheel loads from baggage transfer tugs and other airport vehicles passing overhead. The tunnel roof had to meet a stringent deflection requirement and carried a

*Figure 4. Cantilevered low roof truss supporting high roof framing.*

*Figure 5. New tunnel floor adjacent to existing tunnel.*

*Figure 6. Soil retension system at existing electrical room.*

thin-set terrazzo floor finish. The cheapest and most quickly built solution used 12-inch thick hollow-core concrete planks spanning approximately 30 feet and supporting a 4-inch concrete topping slab. At the end of the tunnel where its width was at a maximum of 48 feet, the roof was composed of a cast-in-place, pan-formed, beam-and-slab system 25 inches deep.

The new terminal building is more than 1,000 feet long and was constructed in three approximately equal sections connected with two expansion joints. The structural system to resist wind loads consisted of concrete moment frames, providing lateral support at the second floor level. Concrete columns at the east end of the building in the ticketing area extend above the second floor and provide lateral support to new steel trusses that are 5 to 8 feet deep. At each

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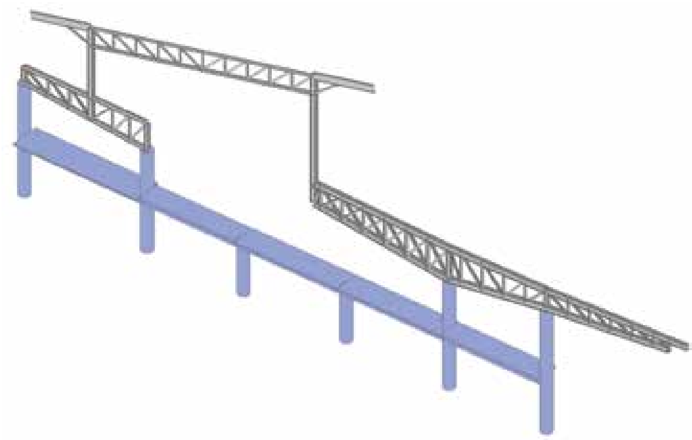

*Figure 7. Low roof truss supporting high roof – RISA 3D model.*

*Figure 8. Curved embed plate.*

column line, there are steel columns supported by cantilevered low roof trusses. These columns extend up and connect to 5-foot-deep steel high roof trusses, and provide lateral support to the high roof framing (*Figure 4, page 38*).

At the west concourse, to give the boarding area a feeling of open space, several column locations were skipped, creating longer spans between columns above the second level. 66-foot-long steel trusses were designed to span this length and support the roof framing. Composite frame action between the concrete columns and the 5-foot-deep trusses provides lateral support for the roof. Curved steel embed plates with hooked deformed bars were installed in round cast-in-place concrete columns as connection points for these steel trusses (*Figure 8*).

A key architectural feature for the new FIS facility is a tree-shaped column supporting sloped high roof framing, located strategically along the existing roadway near the drop-off area of the new terminal building. The tree column has a 4-foot diameter "trunk" which splits into two tapered branches. Like the trunk, each branch is 4 feet in diameter at its intersecting base, and then tapers down to 2 feet at the top. The trunk and branches were rolled and fabricated from half-inch-thick steel plates (*Figure 11*).

Sloped high roof framing at the ticketing area was designed using a combination of long span steel roof trusses, wide flange beams and bar joists supported by steel columns. The high roof steel columns are mounted on the cantilevered ends of the steel trusses of the lower roof. The cantilevered lengths reach up to 35 feet, giving the desired architectural open spaces and visually pleasing high roofs.



## Cloud Room

### *Existing Condition*

One of the most magnificent areas of the new Hobby Airport houses a semicircular projection of the 1950 terminal building, known as the "Cloud Room." The structure originally served as an office space for the airport. The entire area (*Figure 10*) gives the impression, by its size and with electric and natural lighting, of an almost outdoor experience. Passing by the Cloud Room on the way to a gate may make a traveler feel well prepared for flight. However, making this expansive dream come true presented engineering challenges amid the project schedule requirements.

The Cloud Room is located above the lobby of the original terminal, and the desire was to remove columns and provide more uninterrupted space in the area below. Its floor structure consists of a concrete slab on composite metal deck supported by steel floor trusses. The floor trusses were cantilevered out over steel pipe columns with ends tapered out to a mezzanine perimeter. The columns below were arranged in a colonnade pattern bearing directly on the lobby floor.

*Figure 9. Cloud room – existing condition.*

The request was to eliminate these columns to allow a smoother flow of pedestrians, and to increase the beauty and atmosphere of the area.

The architect originally suggested removing the 1950 Cloud Room altogether. However, this would require relocating existing mechanical ducts, electrical, and plumbing equipment serving the main lobby, which would have required an interruption of heating and cooling for a substantial duration. This would come at a much greater cost to the owner than the actual solution which was implemented.

### *Structural Solution*

The solution was to support the Cloud Room from the roof structure and then remove the columns below. H+R designed a system of beams and steel pipe hangers in the same geometry already present in the colonnade orientation, and coordinated with the existing MEP system. The hangers were spliced with the existing pipe columns extending up to the 1999 addition's long span steel trusses.

To minimize the additional weight added to the high airport roof's steel trusses, existing miscellaneous framing at the penthouse floor and roof structure was removed, and an in-plane truss system was designed to provide the lateral stability for this hanging penthouse structure. The existing roof trusses were analyzed using 3D analysis software (RISA-3D) and some trusses had to be reinforced. Subsequent to the installation of the hanger supports, and with the new reinforcement in place, the existing columns bearing on the lobby floor were removed. The process was well-planned and sequenced to minimize impact loading. The general contractor monitored deflections of the high roof trusses during this procedure, and all measured less than ½ inch, well within the code prescribed limits. The solution prevented interruption to MEP services and proved economical as well as architecturally beneficial to the project.

## Houston's Hobby Airport Deserves Enthusiastic Celebration

If you find yourself traveling in the near future, on a domestic or international flight into or out of Houston, you will be able to enjoy with some enthusiasm and interest what might otherwise be a mundane, ordinary trip out of town. The enterprises that process passengers on their way with efficiency have made it possible for us all to travel in comfort. This is due to the cooperation and coordination of many inter-related facilities found at the airport, all housed in massive structures of concrete and steel.

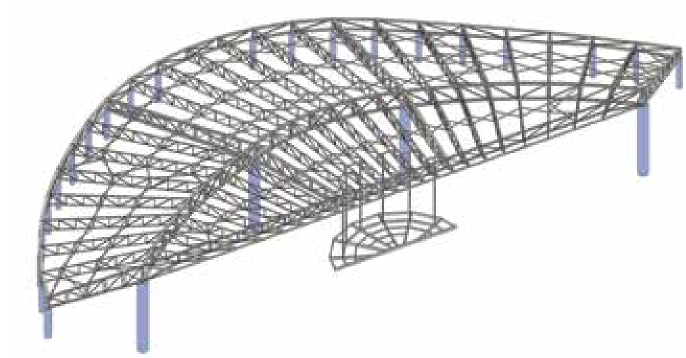

*Figure 10. Cloud room – RISA 3D model.*

*Figure 11. Tree column.*

In Houston's Hobby Airport, these facilities were made possible not only by HAS and Southwest Airlines, but by architects, structural engineers and builders who met many challenges and solved them with creativity, advanced technology and hard work. When you visit Hobby Airport on your way through Houston, take a look around and consider all the elements that went together to make such an important aviation facility beautiful as well as functional.▪

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