Cape Town International Airport

INTRODUCTION
In June 2005 ACSA decided to proceed with the development of the Cape Town International Airport, considering the successful bid for the 2010 FIFA World Cup. The original scheme had been put on hold in January 2004.

PROJECT DESCRIPTION
The design of the new central terminal buildings forms part of the overall long-term master plan. This required the following:

- A new central terminal building which combines the international and domestic departures terminals to meet passenger numbers to 2015, and which are expandable to meet passenger figures projected to 2025.
- A new elevated roadway to service departing passengers on the second floor.
- A new elevated corridor link to connect the central terminal buildings to the existing international building.
- A new domestic departures lounge and arrivals corridor.
- Eight new airbridges to convey passengers from the new buildings to the aircraft.
- Enlarging and upgrading the existing arrivals building and a new corridor link to the central terminal buildings.
- Space for a new fully automated baggage handling system.
- A new bus boarding facility to transport passengers to aircraft on remote stands.

1

CAPE TOWN INTERNATIONAL AIRPORT – NEW TERMINAL BUILDINGS AND ELEVATED ROADWAY

Technical Excellence category

KEY PLAYERS
Client Airports Company of South Africa
Professional Team Blueprint Worx, KFD Wilkinson, AKI (subconsultants for domestic departure lounge), KV3, Triocon, Basil Nair & Associates, Keith Fletcher & Associates
Main Contractor GLS JV
Major Subcontractors and Suppliers Form-Scaff

DESIGN APPROACH
The various components which make up the above facilities at the Cape Town International Airport have utilised different structural forms to achieve technical, aesthetic, cost and constructability requirements. They can be summarised as follows:

The central terminal building
- The suspended floor slabs were constructed using 625 mm deep post-tensioned troughed and coffered slabs. These were required to span the 18 m x 10 m column grid.
- A structural steel feature roof supported on inclined struts to create a strong image and identity reminiscent of 'flying'.

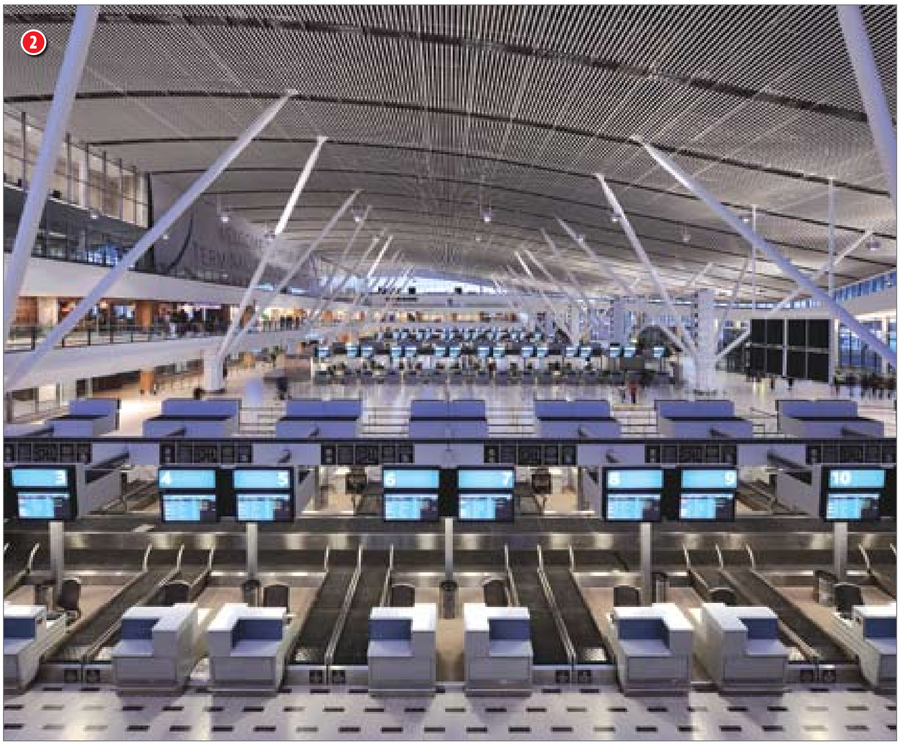
Elevated roadway
- An in-situ concrete voided deck was utilised for economic and aesthetic considerations.

1 General view of the central terminal building during construction showing the 525 mm deep troughs for the 625 mm post-tensioned slabs spanning 18 m, and the erection of the roof structure on temporary vertical towers. Also evident behind the support towers is the portion of structure which could not be constructed due to the phased handover of the baggage handling installation

2 General view of the check-in hall from the upper food court floor

3 Installation of the main support columns and raking struts (457 mm diameter) below the temporarily supported roof structure. The main support columns have the dual function of structural support and as the main air supply shafts to the check-in hall

4 General view of the completed check-in hall. The photograph shows the raking supports to the main roof structure, the main support columns with the air shaft and nozzles and the tubular ceiling



- The deck was supported on Y-shaped columns within the main central plaza to maintain the structural theme of the central terminal building.

Elevated corridor link to international departures lounge

- In-situ concrete with a structural steel cantilever roof which 'hangs' the corridor over the existing terminal building.

Domestic departures lounge and arrivals corridor

- Concrete substructure.
- Structural steel and bonddek construction was utilised due to programme and geometric constraints.

Interface building between the central terminal building and the domestic departures lounge

- Due to programme constraints a combination of in-situ concrete, structural steel and bonddek was utilised. A precast concrete option was investigated, but due to all the major precast contractors being involved with the stadium, it would not have been possible to meet the tight construction programme.

Airbridges

- These were constructed of prefabricated structural steel girders which could be lowered into place at night so that the normal operation of the airside road and the apron would not be interrupted.

Upgrade of the existing Domestic Arrivals

- Structural steel was utilised for economic considerations.

The design complexities encountered included the following:

Stair and lift shafts commencing on second floor

The central escape stairs and elevator shafts could not extend below the second floor as this would impact on the space required for the baggage handling and domestic bus lounges. The solution was to provide a series of deep transfer beams at the second floor level.

Changes in levels and ramps

The floor levels of the various buildings are dictated by the passenger boarding bridges. These vary depending upon the aircraft type being boarded. This resulted in the extensive requirements for ramps which created both design and construction challenges.

Designing for out of sequence construction

The site for the new central terminal building contained three facilities which were in use and could not be demolished until new facilities had been provided. These included the international baggage handling room, main electrical switching room and the protocol lounge.

An expanded brief during construction

The Client increased the width of the main terminal during construction to meet a requirement for additional retail

5 General view of the construction of the structural steel domestic departures lounge and arrival corridor over the existing airside road with the central terminal building in the background. The building is supported on the concrete columns in the foreground which allow free access for the vehicles below the building

6 The arrivals corridor for the domestic arrivals is contained within the main girders which span over the airside road. This was achieved by locating the corridor within the zone of minimum forces which were accommodated by 'vierendeel' action

7 General view showing the proximity of the site to the operational airside area. The photograph shows the construction of the boarding bridges in the foreground, glazed façade, link structure to the existing international departures and the entrance to temporary baggage handling facility

8 General view of the central arrival plaza showing the clad feature girder supporting the roof over the elevated roadway and the Y-shaped columns supporting the elevated roadway

space. The width of the elevated roadway was also increased to include an additional lane for future expansion.

Domestic departures lounge

Designing the new departures lounge in an 'airside' location over the existing airside road meant that the building was subject to geometric constraints. The underside of the structure was subject to a minimum clearance for airside vehicles while the floor levels were dictated by the departing passenger boarding bridge levels.

The main roof

The roof over the central terminal building and elevated roadway had the following complexities:

- a roof curved in both plan and section
- the complex distribution of forces and deflections caused by the inclined struts
- the erection sequence
- rainwater disposal

Joint operations control room (JOC)

The construction of the JOC required the installation of a structural steel floor at the uppermost level (for programme considerations).

RELEVANT GENERAL FEATURES

The relevant general features can be summarised as follows:

- The ceiling to the central check-in building posed a programming and cost problem which was overcome by the use of 65 mm diameter, epoxy-powder-coated aluminium tubes in a grillage to form a ceiling. This option solved the following problems:
  - requirement to commence erection of the ceiling whilst the building was not enclosed
  - acoustic requirements
  - fire requirements
  - aesthetic requirements
- Syphonic rain water disposal system to the main roof.
- Tapered ends to the supporting struts. After investigating all the options for creating a tapered end to the struts, the tapers were formed by pressing two tapered halves and welding them together.
- Steel columns supporting the raking struts. These cylindrical steel columns double as the support for the raking struts and as the air supply duct to the nozzles which feed conditioned air across the check-in area.
- The external feature girder was designed as two independent structures, connected on the centreline by a pin to prevent any differential movement. The 30 m cantilever was pre-deflected by 150 mm.

CONSTRUCTION TECHNIQUES

Construction activities were in a fully operational environment and adjacent to existing structures. The following construction techniques were utilised:

- Piling: Franki driven piles were generally used except where piling was in extremely close proximity to existing functioning buildings where continuous flight auger piles were utilised to minimise the noise and vibration effects on passenger comfort and equipment sensitive to vibration.
- Various methods were used for both temporary and permanent underpinning to existing structures. These included caissons, driven H-piles and mass concrete.
- The methods of erecting the roof required the main girders to be supported on temporary towers until the inclined struts had been fixed into place.
- Utilisation of the permanent structure to support very high construction loads including mobile cranes. The two western cranes were built through pockets in the suspended slabs. On completion of the roof trusses they were removed. This required the use of a 90 ton crane that was driven onto the elevated roadway and the central terminal building's suspended slab. Special temporary transfer

pads were cast on each level to distribute the load to the support props which extended to temporary foundations.

- The existing potable water, sewer and storm water systems were required to be kept operational during all construction phases.
- The need to maintain vehicular and pedestrian traffic required that many ducts, water and sewer pipes were installed by trenchless methods.

OTHER CONSIDERATIONS

Implementation of the project was complicated by the following factors:

- The requirement to keep the airport and all its services fully functional during the entire construction process.
- Very limited information on as-built services and existing structures.
- Lengthy airport operational hours which severely limited the time available to complete any construction work required to be done during non-operational time.
- Not having full access to the site at the start of construction. This lead to a complex construction sequence which had to change frequently to accommodate changes in the availability of the site.
- An expanded brief during the construction phase.
- Extensive 'airside' work which comes with its own set of rules and regulations.
- Interfaces with other construction contracts at the airport.
- A scarcity of resources due to a general construction boom during the contract period.

These issues were managed by the team on an ongoing basis and resulted in many innovative and interesting solutions. These included the erection of temporary tents and links on the airside apron for use as a temporary departure lounge thereby enabling the earlier construction of the new domestic departures lounge, the use of structural steel where time advantages could be gained, fire engineering to limit the extent of fire proofing required and the use of caissons as lateral support for the construction of pile caps to prevent the undermining of existing structures.

The main environmental aspects of the project were to maintain a clean 'airside' environment for the safe operation of the airport and a functional 'landside' environment for the passengers during all the construction phases.

SUMMARY

The central terminal buildings are highly utilised public spaces which often create the first or last impressions of Cape Town for air travellers. We believe that sound, innovative and appropriate engineering principles have provided a facility which not only enhances the passengers' experience but also provides the Client with a building which is functional and economically sustainable into the future.

The new terminal buildings and baggage handling system have been operational since November 2009 with no significant problems. In fact, the buildings have received only high praise from the general public. ◻