

Opening new doors in Swaziland

GIBB engineers the Sikhuphe Airport control tower

In 2003, the Kingdom of Swaziland embarked on construction of the \$150-million Sikhuphe Airport project. This formed part of King Mswati III's \$1-billion millennium project investment initiative to enhance Swaziland's position as a leading tourist destination in the region.

GIBB, one of Africa's largest multidisciplinary consulting engineering and science companies, was responsible for designing the key structures of the Sikhuphe Airport – a project that highlighted its expertise and multidisciplinary workmanship.

The Kingdom of Swaziland determined the need for an international airport capable of accommodating the most contemporary of the large international aircrafts.

The project area is situated in the Swazi lowlands at Sikhuphe, which is close to Siteke and the sugarcane plantations and game parks to the east, yet not too far from the capital Mbabane or its neighbouring town of Manzini. Finding sufficient flat ground in "the Mountain Kingdom" to accommodate both the runways and the control buildings was not a simple task.

The project was multifaceted and these diverse, complex divisions were disseminated among several consultancies. The Swazi

Consultancy of DTA was asked to design all the critical installations and buildings associated with administrating the airport.

GIBB engineer Pat Masterson says, "DTA sub-contracted GIBB to do the structural design of the airport's critical structures, including the control tower, the Air Traffic Control Building and the fire station. Of the most interesting facets of this project was the control tower.

"The contract for the construction of these buildings was awarded to Stefanutti Stocks. The design of the control tower was particularly interesting and challenging," Masterson continues. "And because of the position of the land, it had to be built on ground at a level below the runways, yet still be capable of reaching high enough to see the ends of the runways."

This resulted in having to design a much taller tower than would generally be expected, with a total height of 57 metres. Consequently, this presented a number of unique design challenges.

There are also a number of unusual shaped transformations incorporated in the architectural concept of the tower. The main structure encompasses a rounded triangular shape (47.8m high with 200-millimetre thick concrete walls) built on a hexagonal base, which are founded 5m below ground level on

rock. Above the 47.8-metre high tower walls is the technical level, which is constructed on a cantilevering, octagonal shaped, composite slab and comprises a 16-sided structural steel cage. This in turn supports the actual Visual Control Room (VCR) or cab. The cab is octagonal in shape and is built on a composite slab supported on an upstand beam. There is a circular shaped balcony at a slightly lower level. The VCR itself is imported from the United Kingdom and is lifted up onto the structure using a tower crane.

The natural frequency of the tower became an area of concern and calculations indicated that based on the ratio of the mass, moment of inertia and height of the tower, the natural frequency of the structure was in a zone where a more in-depth look into the design was required.

The natural frequency of the tower fell just outside the 10% range of the wind vortex shedding frequency that would cause resonance of the tower under certain design wind speeds.

Different methods to change the natural frequency of the tower, without completely changing its architectural aspects, were considered. The design selected was to reduce the functional height of the tower by increasing the rigidity of the lower portion of the tower. To do this, wing walls were added as braces at



the bottom of the tower. These wing walls are constructed from the foundations up to a level of 2.6m above the lower entrance to the tower.


Both the mass of the tower and the effects of moment of inertia had to be kept in mind when designing the wing walls. By adding the wing walls, it was possible to increase the moment of inertia of the tower and to achieve a reduction in the effective length, without sufficiently increasing the mass.

The shape transformations at the top of the tower, together with the size of the steel cage and VCR at the top of the tower, also change the wind vortex shedding frequency to the benefit of the design – with a final solution that reflects the architectural intentions while at the same time providing a robust structural solution.

Stefanutti Stocks opted for a slip formwork construction, similar in principle to the many other pours it has successfully done at other airports. "It was a pleasure to work with this professional team and the entire pour went ahead with minimal complications, with the most unpleasant being that it was poured during the heart of winter and low concrete temperatures led to slow progress at night," says Masterson.

It is expected that the airport will be in operation later this year and Swaziland will then be able to celebrate having a modern, fully functional international airport capable of receiving the large aircrafts that fly to Europe and Asia.

GIBB is a multidisciplinary engineering and science consulting company staffed with professional engineers, scientists and managers within a broad range of 11 sectors: Advisory Services; Airports Engineering and Aviation Services; Building Services; Dams, Hydropower and Underground Works; Environmental Services; Human Settlements Services; Mining and Metallurgy Services, Power and Energy Services; Railway Engineering Services; Roads and Highways Services, Traffic and Transportation Services.

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