

## GEOTECHNICS OF TRANSPORT

# WHAT LIES BENEATH

Gatwick Airport is benefiting from a wide-ranging GPR survey to help deal with bigger plane loadings and planning pavement maintenance.

Airport operators face growing pressure to keep traffic moving on the ground while maintaining runways, taxiways and aprons. An added complexity is the need to assess and upgrade pavements for increased loadings from bigger planes.

In the UK, airport operator BAA is leading the way in the use of ground penetrating radar (GPR) surveys to assess underlying pavement condition and spot problems before they surface. This will help avoid unplanned repairs and costly service disruption.

To improve the planning and budgeting of airside pavement maintenance, BAA is investing in a rolling programme of GPR data collection from runways, taxiways and aprons at Gatwick Airport, south of London. This commitment to GPR, which maps the construction and condition of pavement structures, follows successful trials at Gatwick over the past three years.

Fugro Aperio has been doing the surveys through BAA's maintenance contractor Dyer & Butler. BAA's civils maintenance team initially used GPR to map voids under a problematic section of taxiway, but it soon decided to widen the survey's scope to capture the whole airside pavement network.

Gatwick Airport uses the tech-

nique to plan maintenance on a long-term basis and manage its operational impact. The surveys produce evaluative data on the thickness of pavement layers. They also provide a precise map of the extent of defects, such as delamination between layers and areas of voiding below the concrete or asphalt.

Ground conditions at Gatwick are particularly challenging as it has a high water table and sits on two water courses – the River Mole and Crawlers Brook.

Airport lead engineer for building and civils at Gatwick Girish Reesaul says: "GPR is primarily used in identifying voids within various pavement layers, detecting the presence of excess water in its structure, and investigating significant delamination between pavement layers. It is also used to check as-built information confirming thickness of layers where limited information is available."

"GPR results are used in conjunction with data from other investigatory methods to identify areas of poor performance, prioritise maintenance activities and validate the data from our predictive pavement deterioration models. This will enable an efficient maintenance plan to be put in place."

About 80 airlines operate out of Gatwick, which handles 865 air-

craft movements per day and up to 3.4M passengers a year. New and reconstructed pavements are being engineered for 400t Jumbos and for similar loadings from the wheel-set of the Airbus A380.

GPR helped evaluate the condition of the Alpha hold taxiway, one of the older sections of airside concrete, for carrying larger aircraft. Results showed problems with the area below the concrete, which was confirmed by a series of test cores.

Reesaul says: "Areas of asphalt and concrete were breaking up and the pavement was subject to some movement. We needed to understand what was happening using a fast and non-invasive method so we

could keep the taxiway operational. GPR provided a fast, non-destructive way of providing the detail needed for an accurate assessment of condition."

BAA project leader for Pavement and Infrastructure Jeremy Rowton says: "The GPR results validated the assumptions relating to the presence of voids and helped confirm the need for full-depth reconstruction. The project is providing a new composite construction taxiway and relocating the centreline to provide lateral clearance for the introduction of larger aircraft."

Work began in January with completion planned for March 2008.

In addition, GPR is helping to

### Voiding

Void detection through ground penetrating radar (GPR) is important as even small areas under a pavement can lead to surface cracks and broken slabs. Airport lead engineer for building and civils at Gatwick Girish Reesaul says: "GPR identifies potential problem areas and helps define the scope of works. An example of this is a large area of faulting, settlement and localised mud pumping that was visible on the surface of Taxiway Lima. GPR assessed the extent of voiding under the concrete bays. The scope of the works included areas of trafficked pavement considered high risk due to the magnitude and extent of subsurface voiding, even though these areas did not display significant settlement and faulting distresses."

Site workers corrected the problem with full-depth reconstruction, including the installation of an improved sub-base layer and sub-soil drainage.

moderate and prioritise maintenance plans, and more accurately forecast spend over the short, medium and long term. While flagging no immediate concerns, results for the Juliet taxiway indicated the needed for maintenance within the next five years.

Planning and budgeting work with the help of GPR reduces the headache of reactive maintenance. Reesaul says: "Gatwick Airport is committed to using GPR. We have planned a rolling annual GPR survey programme that would cover the whole of the airside aircraft pavements within five years."

Since the cost of reconstructing and/or overlaying an aircraft pavement is greater than the cost of maintaining it, survey data can help airport operators avoid expense on overengineered solutions.

GPR can also identify pavement conditions that may contribute to foreign object debris (FOD). About 40% of FOD is generated by broken concrete and stones. The technique can detect delaminating materials (concrete and asphalt) before loose pieces break off.

Gatwick is built on clay so pavement structures are more affected by surrounding conditions as the ground expands and contracts during wet and dry cycles. In these more reactive conditions, material can loosen at the pavement joints or asphalt can detach from the concrete under aircraft loading, creating FOD.

The growth of pavement management systems (PMS) in the airport sector is another driver behind the increasing use of GPR.

Most large airports have a PMS

– a geographically referenced database that stores a huge range of asset condition and construction information. PMS can help determine the best management strategy, for example, where to repair, and the cost implications of carrying the repairs out now or leaving them until a later date.

GPR results can be put into most PMS. Instead of reacting to surface failures, GPR gives a view of underlying conditions, highlighting areas where failure is likely to occur. This means repairs can be done during planned closures and targeted at areas where they are needed.

Reesaul says: "Gatwick Airport has a pavement management system primarily based on the pavement condition index, complete with deterioration models for different families of pavements."

"The system is supplemented with data from various investigations, one of them being GPR. The investigations paint a picture that contributes to the scoping and planning of maintenance jobs and capital projects."

BAA is the first airport client to use Fugro's latest advance in integrated satellite positioning technology and GPR collection.

The company has recently developed the capability to drive its data collection systems through real time kinematic (RTK). It claims this allows collection of more data on site, involves less time setting out for surveys and substantially improves the definition of target features.

The firm says the recent integration of its geophysical surveying with RTK is perhaps the biggest change since computerised process-

ing of digital data was adopted a decade ago.

Until now most GPS systems for geophysical surveys used either radio correction or temporary base stations on site and had a level of accuracy of 0.5m at best. The latest RTK systems use a remote link to a set of permanent base stations. Fugro says that once locked into a station, the measurements are typically good to under 10mm accuracy.

The company says the new capa-

bility provides a number of benefits. A digital drawing of the site allows a survey team to plan measurement positions and programme them in before they arrive. Also, improved positioning linked to permanent, rather than temporary, base stations makes it easier to come back to a site to monitor changes. But it claims the biggest advantages are found on large sites with relatively few obvious landmarks, and sites where time is in short supply.



GPR is helping to moderate and prioritise maintenance plans



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