Terminal 4 at Hamburg Airport consists essentially of two levels. At the lower level there is the arrivals area for incoming passengers and also transport connections, whereas the upper level is for departures. Part of this upper level includes a concrete cantilevered approachway which was to be cut away to allow future expansion work to be carried out. At the time the work was to be carried out, this approachway could only be reached via a temporary bridge, because of other building work being carried out such as the construction of a section of the S-Bahn (tramline) and the building of a new multi-storey car park.

Because of all this building work, traffic management was more than difficult throughout the entire project. A demolition plan was developed by German company, J. Draeger Betonrückbau GmbH & Co KG, which involved carrying out the dismantling work without causing vibration using diamond drilling and sawing in combination with high-pressure water jetting. Considerable value was placed on causing as little nuisance as possible to passengers.

As well as dismantling the 3.65 m wide and 280 m long approachway (Fig 1), two connecting bridges – one pedestrian, the other vehicular – also had to be partially dismantled. Both these bridges had to be shortened by about 8 m in length.

Demolition plan

The plan involved first of all removing on the demolition side a 0.5 - 1.0 m wide strip of concrete using a Conjet high-pressure water jetting machine and a 750 hp high-pressure pump to a depth of about 15 cm (Fig 2). This was to allow the reinforcement bars in the cantilevered concrete the approachway to be exposed without causing any damage. These were needed for connecting new reinforcement at a later stage in the building work. Then, a 10 mm diameter diamond wire had to be pulled under the reinforcement, guided by pulleys such that the remaining concrete beneath the reinforcement exposed by the jetting could be cut downwards. In this way the reinforcement bars that had to be retained were not damaged.

Considerable preliminary work had to carried out prior to any jetting or cutting could commence. This involved propping the 280 m long cantilever of the approach with falsework, as well as setting up safety screens for the vehicular and pedestrian bridges. There was also the setting up of a steel framework to provide access for passengers at the exit of the detour of the airport, and setting up support towers to the approachway and scaffolding for cutting the cantilever into concrete sections each weighing about 40 tonnes. The mobile cranes to lift the concrete sections also had to be set up and the transport logistics and the disposal of a total of 1,500 tonnes of concrete had to be arranged.

Work started with the smaller footbridge. A noise protection cage for the high-pressure water jet machine was assembled at the Draeger premises. The water jet machine was intended to work from inside this cage so that passengers would be disturbed as little as possible by the noise caused by the water jet, which exits the nozzle at 1.8 times the speed of sound. After the preparatory work had been completed the cage was installed at the construction site.

Then the high-pressure machine could jet free about 19 linear m in a shift, which

The silver Diamond Award 2004 organised by the IACDS went to German company, J. Draeger Betonrückbau GmbH & Co KG for its work at Terminal 4 of the Hamburg-Fuhlsbüttel Airport. A combination of the methods of high-pressure water jetting, diamond drilling and sawing was used in the demolition work. Report by J. Draeger.
Construction

A volume of 4 m³ per day was removed by jetting. Once the jetted surfaces were produced (Fig 3), 50 mm diameter cores were drilled to install the diamond wire and remove the water. Cores were drilled every other core to pass the wire through, and an additional core with a 250 mm diameter was drilled from below to stop just below the reinforcement level. These cores received a guide pulley to facilitate the wire's passage and operation.

Bridge removal

Eight 200 mm diameter cores were made in the footbridge to lift a 60 tonne section. At the same time, a 30 tonne concrete section was cut out using two wire saws, which was lifted away with a 250 tonne mobile crane. The second section was lifted out of its bed joint and moved away without any sawing. Temporary work was completed in a day.

While two teams worked on the footbridge, a third team continued the water jetting work from the vehicle bridge. After the jetting, the cavity was blown out using compressed air. Two diamond wire saws were used at the same time to make separating cuts every 7.8 m. Lengthwise cuts were made from below under the reinforcement, allowing cut sections to remain only on the load towers that had been set up beforehand. Four cores (250 mm in diameter) were drilled into each concrete section to take lifting cables. After 60 mm thick steel cables were inserted, reinforcement bars were cut using a bolt cutter. The 40 tonne sections were removed one at a time, lowered by about 20 cm, and moved sideways before being dropped onto the low loader below (Fig 1). This process allowed four concrete sections to be removed, loaded, and disposed of daily. After four days, more than 100 m of the approach table had been completely removed.

As the work progressed, passenger walkways were installed in the area already demolished, and the vehicle bridge was propped with scaffolds over its 8 m length. The bridge section to be removed weighed about 120 tonnes and was cut into four sections of about 30 tonnes each, removed, and disposed of.

Sudden collapse

However, while the vehicle bridge was being demolished, a section of the approachway suddenly collapsed. Several 90 mm diameter reinforced concrete pillars (with a 3 m x 3 m foundation) disappeared in the earth, forming a crater about 12 m in diameter. The three concrete sections that had already been cut and weighed 40 tonnes threatened to collapse, with the load towers bending like matchsticks (Fig 5).
The cause was probably a joint below ground between the S-Bahn station work and the S-Bahn tunnel, through which ground water had been seeping. In this process the ground water had flushed sand and other sediment through the joint so that an ever-larger hollow space formed. As this was only 1 m away from the surface, due to the force of gravity a 100 mm pipe that was part of the local hydrant system broke and at a pressure of 6.5 bar flushed away the rest of the subsoil.

The emergency alarm was triggered at once. The damaged approachway was closed off at once since a joint had formed on the surface giving a difference in level of 0.5 m and bringing chaos with it. Departing passengers were unable to drive to Terminal 4 and had to carry their luggage, some of it heavy, for kilometres as the emergency service and police had closed off the site over a large area. Every other plane was now taking off virtually empty because the passengers were no longer able to catch their flight on time.

As a first measure, 150 m³ of concrete was pumped into the crater that had been created in order to prevent the approachway from slumping any further. But there were still the three cut concrete sections hanging on the building, each weighing 40 tonnes. The load towers were unable to bear any weight now. The concrete sections were held only by their reinforcement and there was a risk that they would collapse. To salvage these sections, a bridge had to be put in place over the S-Bahn tunnel that was being built so there was a distance of 40 m to be bridged from the middle of the revolving crane to the middle of the concrete section. This could not be done with a 250 tonne mobile crane, and a 650 tonne crane had to be put in position.

After the 650 tonne crane had been put in position, the first concrete section hanging on by its reinforcement was secured. All the work had to be carried out from above from articulated platforms as there was the danger that the concrete sections might become detached from where they were being held and fall to the ground. After the cables had been introduced, the first section of concrete was pre-tensioned to about 37 tonnes and the reinforcements were burned off.

The crane could now raise the concrete section about 20 cm so that the load towers could be removed and the concrete lifted clear (Fig 6). It took a day to salvage the three sections.

After this unplanned work, the team returned to their normal activities and over the following days quickly demolished the whole of the approachway. In all, a total of 1,500 tonnes of reinforced concrete was removed, cut up and disposed of.

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