



Heavy Loads on Weak Foundations

by Kazuhiro Nii and Dr. Yun Zhang

The newly opened D-Runway at Tokyo International Airport Haneda was a complex structure to build, as it is located on reclaimed land. Heavy airplanes weighing hundreds of tons each, take off and land on the newly constructed runway daily. Continuous monitoring is important for safe operation, as large movements can influence the safety of the runway.

D-Runway was constructed on Japan's first hybrid structure at the mouth of Tama River in Tokyo Bay, consisting of reclaimed land, platforms of piers, and a taxiway, all connected to the present airport. In the landfill portion, soil needed to be improved and re-filled to prevent consolidation subsidence caused by weak foundations. At the pier site, steel pipes nearly 100m long were sunk into the sea at specified intervals. A cover was built around it to keep the river flowing smoothly.

With this complex structure and construction method, the connection between landfill/pier as well as

the joints between pier/taxiway were assumed to be moving and/or to sink due to secular change. Movements must be accurately measured, especially during earthquakes, as the amount of movement is one of the criteria used to assess whether D-Runway is in a satisfactory condition for safe operation or not.

Installation of the System

The monitoring system was designed for maintenance and management of the runway with its complex characteristics. Dozens of GNSS monitoring points were installed and have been monitoring secular changes as well as any movements during earthquakes since the runway was opened. The system measures the movements of two relative positions; sets of two points were installed in these positions across the joints to measure the movements at the joints in the different structures.

Antennas were installed at ground level near the runway at the landfill and pier sides to avoid interference with aircraft operation, and at the taxiway they were installed at points outside the airport height restriction.

A Leica GMX902 GG with an AX1203+ GNSS antenna were installed on the roof of the Fire Department's east building at the side of the airport, rather than near the runway. The antenna was seismically isolated by fixing a vibration absorber around it so positioning can be performed even in the middle of an earthquake. Since antennas were put in the ground, data reception may be disrupted by aircraft activity, so the system also collects data using GLONASS signals to maintain a horizontal accuracy of 10mm (0.39 in).

Data Collection & Analysis

Monitoring data captured on the runway is transferred to and analyzed by the server located in the monitoring control room in the Fire Department building. Both Leica GNSS Spider and custom designed monitoring software for D-Runway, developed by Leica Geosystems' partner Geosurf Corp. (Tokyo, Japan), are running on the server. Spider continuously analyzes the data at 20Hz and outputs the results to the Geosurf software with a GGQ message uniquely developed by Leica Geosystems. It converts world geodetic coordinates to plane coordinates based on the runway, and then uploads collected data in files to the government server.

The processing system broadly consists of three tasks: constant airport taxiway and runway monitoring, earthquake monitoring, and post processing of an earthquake. Constant monitoring performs real time analysis, transferring LB2 data from monitoring points to Leica Spider via socket communication, by TCP/IP. It calculates each median of the 3D coordinates from data at 20Hz every two hours. It can also improve the accuracy of the results by getting final medians after deleting false values caused by IQR (inter-quartile range). The earthquake monitoring system can capture the exact start and end times of earthquakes by receiving electric trigger signals from the seismometer installed on the runway. ■

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Tokyo International Airport Haneda

The Haneda Airfield first opened in 1931 on a small piece of waterfront land at the south end of today's airport complex. In 1939 the airport's first runway was extended to 800m and a second 800m (2,625 ft) runway was completed.

In 1964, Japan lifted travel restrictions on its citizens, causing passenger traffic at the airport to swell. A new runway and an international terminal were completed in 1970, but demand continued to outpace expansion.

The fourth runway, D-Runway, was constructed via land reclamation to the south of the existing airfield and was completed in 2010. This runway was designed to increase Haneda's operational capacity from 285,000 movements to 407,000 movements per year, permitting increased frequencies on existing routes, as well as routes to new destinations.

Source: Wikipedia