**Data Collection and Their Usages for Airport Pavement Management System in Japan**

Yoshitaka Hachiya, Takashi Watanabe and Takehiko Kouda
Service Center of Port Engineering (SCOPE), Tokyo, JAPAN

Futoshi Izu and Hayato Tou
National Institute for Land and Infrastructure Management (NILIM), Ministry of Land, Infrastructure, Transport, and Tourism, Yokosuka, JAPAN

**BACKGROUND**
Once an airport pavement has been opened to traffic, proper maintenance and rehabilitation works are essential to maintain the functionality of pavement at a satisfactory level and to extend its service life. Maintenance and rehabilitation strategies were conventionally based on empirical and subjective judgments by airport administration staffs. Therefore, a systematic method for implementing maintenance and rehabilitation works, that is, an Airport Pavement Management System (APMS), has been required. Some subsystems of APMS have been developed through the exchange of ideas, information and resources, between NILIM and SCOPE, and are coming into practical use in Japan.

**OBJECTIVES**
Description of the current state of APMS for asphalt pavements in Japan.
1. An outline of the maintenance and rehabilitation subsystem
2. An inspection registration tool in the inspection and maintenance phase
3. Some tools used in the soundness evaluation phase to evaluate the surface condition, structural condition, roughness, and the durability of surface materials
4. The rehabilitation budget allocation system for rehabilitation optimization, Airport Pavement Optimal Rehabilitation Timing System (AirPORTS)

**EVALUATION AND REHABILITATION SUBSYSTEM OF APMS IN JAPAN**
On the basis of various studies of airport pavements, such as investigations on surface condition evaluations, structural evaluations, prediction of distress and performance, and maintenance and rehabilitation strategies, the procedures for design, evaluation, and rehabilitation, which form subsystems of a complete APMS were developed. The maintenance and rehabilitation subsystem consists of three phases as shown in **FIGURE 1**: an inspection and maintenance phase, a soundness evaluation phase, and a rehabilitation optimization phase.

**INSPECTION AND MAINTENANCE PHASE**
In the inspection and maintenance phase, airport pavements are visually inspected periodically (daily and monthly) and emergently when a large earthquake happens, and then some maintenance works will be executed if necessary. Through the monthly inspection patrols, various data on pavement distress can be quantified and traced, and then remedial actions which can be determined automatically will be executed.

**Components of the New Inspection Patrol System**
The system developed in this study uses a mobile PC and a differential global positioning system...
(DGPS), to lessen the inspector's work.

1. Mobile PC: usable in all weather conditions and during the day and night, with a touch-screen, and having high portability and durability
2. DGPS: comparatively inexpensive, cost-effective, and having high portability

**PHOTO 1** shows an inspection patrol working on the airport pavements using this system. **FIGURE 2** shows the decision flowchart for the inspection patrol system.

**Process Summary of the New Inspection Patrol System for Airport Pavements**

**Identification of distress:** The position is obtained using the DGPS and displayed in plan view on the PC screen. Simultaneously, the position coordinates, the name of the pavement where the distress is found, and the type and state of the distress can be easily recorded. The error associated with the coordinates falls in less than 1 m by averaging three measured DGPS data and using correcting information from a Multifunctional Transport Satellite (MTSAT) with a Multifunctional Satellite Augmentation System (MSAS).

**Evaluation and treatment of distress:** The evaluation and the necessary treatment of the distress could be determined automatically when the type and the state of distress is known. This is performed by the judgment system based on both past experience of distress treatment and the opinions of highly experienced inspection engineers. This could help the less-experienced inspection engineers to respond appropriately to the distress and could decrease differences in opinion among the inspection engineers.

**Description and photographing of distress:** Because a Geographic Information System (GIS) is used in the new inspection patrol system, different layers can be assigned to the airport plan view, facility inventory figures, surface condition survey units, inspection routes, and past inspection history so that they can be managed efficiently.

**Reporting of distress:** All the data can be stored in a comprehensive database system and the register can also be created in a semi-automatic manner.

**SOUNDNESS EVALUATION PHASE**

In the soundness evaluation phase, a detailed inspection on the pavements is conducted basically at three-year interval and whenever required in the inspection and maintenance phase, and then the soundness of pavements is evaluated.

**Surface Distress Evaluation**

The airport pavement surface condition is surveyed with an automatic distress measuring vehicle. The pavement surfaces are photographed with a high-resolution camera or video that allows the detection of cracks having at least 1 mm width, and then the films or tapes are analyzed. Laser scan beams are applied transversely on the surface and pictured to measure the rut depth. Noncontact displacement sensors using laser beams are adopted to measure the roughness. The need for rehabilitation work in a section is classified into three categories (unnecessary, necessary in near future and necessary immediately).

**Pavement Strengthening**

The information needed to strengthen the pavement is collected and the pavement structural design for improving the surface distress and the structure is examined. The load-carrying capacity, safety for aircraft operation, and durability of surface materials are evaluated in this step.
Load-carrying capacity: A Falling Weight Deflectometer (FWD) has been adopted, which is widely used to measure deflections in response to known loads. The FWD system can apply a maximum load of 200 kN through a 450 mm-diameter loading plate. Deflections are obtained at seven points (0, 300, 450, 600, 900, 1,500, and 2,500 mm from the center of the loading plate).

Safety for aircraft operation: Using the noncontact type profilometer, the short wavelength range of at least 1 mm can be measured with the sequential-two-points method (vehicle speed of 144 km/h and measurement interval of 10 mm). To eliminate the accumulated errors resulting in considerable distortion in the long wavelength range, a real-time kinematics-type GPS, having an accuracy of 20–30 mm in a vertical direction, has been combined with the profilometer. FIGURE 3 shows the schematic of the system.

Durability of surface materials: The durability of surface materials is evaluated by relevant, appropriate tests using cores extracted from the site or specimens prepared in the laboratory.

Pavement Preserving
The pavement structural design for improving the surface distress is examined.

REHABILITATION OPTIMIZATION PHASE
Both rehabilitation method and budget allocation are optimized by systematizing the management system taking into consideration the rehabilitation history and the pavement surface condition history. To realize this, the highly precise Airport Pavement Optimal Rehabilitation Timing System (AirPORTS) has been developed using data including PRI (Pavement Rehabilitation Index), rehabilitation cost, etc. on actual airport pavements in Japan.

System Composition of AirPORTS
AirPORTS is built using general-purpose software (Excel and Access). AirPORTS consists of the following four parts. FIGURE 4 shows the result of a sample analysis on the PC screen displaying an optimal rehabilitation plan for Osaka Itami Airport, one of the largest airports in Japan.

Database part: The rate of change in the PRI, the degrees of recovery after rehabilitation works, and the construction unit prices are stored for each rehabilitation work.

Optimal construction method selection part: The optimal rehabilitation procedure to satisfy the lowest required PRI is selected automatically according to the changing rate of the PRI, the degree of PRI recovery, and the rehabilitation expenses.

Yearly rehabilitation expense prediction part: Yearly rehabilitation expenses are automatically predicted for the designated period; that is, the timing, the pavement areas, and the rehabilitation expenses are predicted.

Budget equalization part: The rehabilitation expenses are automatically rationalized according to the yearly maximum budget. In this process, various strategies to accomplish the works within the budget will be adopted, such as the moving forward of the scheduling of rehabilitation works or changing the lowest required PRI.

CONCLUDING REMARKS
The maintenance and rehabilitation subsystem of the airport pavement management system in Japan consists of three phases: an inspection and maintenance phase, a soundness evaluation phase, and a rehabilitation optimization phase. The data collection and analysis procedures in each phase are described in detail. This subsystem is applicable to airports not only in Japan but in other countries with some small modifications, regardless of the inspection and evaluation tools adopted in each airport.