Federal Aviation Administration (FAA) Airport Pavement Management and Airport Pavement Roughness Evaluation

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Abstract

This paper will provide the status of ongoing NDT work by the FAA. PAVEAIR is a web-based Airport Pavement Management System and the FAA is researching airport pavement roughness using a Boeing simulator.

By 2011, the Federal Aviation Administration (FAA) is scheduled to complete a three year effort to create an internet based computer program for airport pavement evaluation and management. This PAVEAIR program, while using existing pavement evaluation databases, will provide a pavement evaluation and management web-based application also functional on stand-alone personal computers by running a local web server such as Microsoft Internet Information Server (IIS). The program will have the equivalent functionality of MicroPAVER version 5.3. Initially the program will be designed to function in Internet Explorer version 6.0 and above web browser. The program will support simultaneous entry of inspection data into the system by multiple users. The FAA envisions an implementation of PAVEAIR containing data for FAA Airport Improvement Program (AIP) projects residing on a server located at the William J. Hughes Technical Center in Atlantic City, New Jersey. It is expected that PAVEAIR will be distributed for implementation by other interested agencies or users.

In 2008, the William J. Hughes Technical Center in conjunction with staff at the Mike Monroney Aeronautical Center (MMAC) joined in a project to study cockpit ride quality using a full-motion Boeing B-737-800 airplane simulator. The initial phase of the project is to verify that actual pavement profile data could be entered into airplane simulator software and accurately simulate the airplane responses excited by the pavement profiles. This simulation, where feasible, would use International Organization for Standardization (ISO) requirements for the evaluation of human exposure to mechanical vibration and shock. The second phase is to rate the known values of the profiles with the ride pilots, flight crew, and passengers would experience. This would be accomplished in coordination with Human Factors specialists who would design the questionnaires and test methodologies to best capture the data. Finally, these results would be analyzed to establish the link between the various airport pavement roughness indexes and the corresponding experience in the cockpit. This project is expected to establish well defined criteria for rating the ride quality of airport pavements and to provide the ride quality component of pavement management procedures for airports.

1. PAVEAIR - Web-based Airport Pavement Management System
1.1 Background

The Federal Aviation Administration has developed and continues to develop and refine Non-Destructive Testing (NDT) technologies to assess airport pavement condition. Recent advances in computer hardware and software and data acquisition systems have significantly improved NDT effectiveness and value. The FAA has developed back calculation software to collect and interpret data from Falling/Heavy Weight Deflectometer equipment. This software, titled BAKFAA, was developed by the FAA and has been available for several years. Results obtained from BAKFAA can provide information on the structural capacity of the pavement layers from measured deflection basins and assuming uniform layer thickness. In addition, the FAA has developed ProFAA, an airport pavement profile evaluation program. ProFAA and BAKFAA are both available to the public at no charge with access to the source code for local modification. The most recent FAA software program currently under development is an internet based computer program for use as an Airport Pavement Management System (APMS). The background for the development of this program is discussed below.

1.2 PAVEAIR Discussion

The National Association of State Aviation Officials (NASAO) and the FAA agreed to partner to develop a system for sharing information to optimize available airport pavement funds. It was then agreed that the development of a web-based airport pavement program would be the optimum method to share this information. FAA Advisory Circular 150/5380-7A, Airport Pavement Management requires the use of a Pavement Management System (PMS) [2]. PAVEAIR will satisfy the requirements of this Advisory Circular and comply with the U.S. Government section 508 accessibility requirements to ensure that people with disabilities have the same access to electronic and information technology as people without disabilities.

The benefits of a web-based pavement evaluation and management program were subsequently determined and are discussed as follows: a method to manage system-wide dissemination and analysis of FAA sponsored pavement projects, a tool to tie volumes of existing airport pavement data together for project/construction comparison, and as a means to join existing FAA airport pavement design and evaluation computer programs together for ease of operation. PAVEAIR, in its’ initial launch, will have the equivalent functionality of MicroPAVER version 5.3 and be designed to operate in Microsoft Internet Explorer version 6.0 and above web browser on the client side.


PAVEAIR is being developed using Visual Studio 2008 and compiled to run using the most current Microsoft Windows operating system to support single-user and server class personal computers. Installation of PAVEAIR will be configured for use on a stand-alone personal computer, a private network, and the internet or an intranet. A user database will be created for each inventory (data owner) and the database engine is Microsoft SQL server. The FAA anticipates hosting a server at the WJHTC as a repository for civil airport projects funded by the Airport Improvement Program (AIP). As with other FAA pavement programs, the PAVEAIR application will be made available for free download by users as a set of installation files, source
code, and documentation for installation and operation. In addition, development of PAVEAIR will be done in accordance with existing industry standards such as; American Society for Testing and Materials (ASTM), FAA Advisory Circulars, and Federal Department of Transportation (DOT) and FAA Information Systems Security (ISS) requirements.

1.3 CONCLUSION for PAVEAIR

The need for accurate and timely airport pavement evaluation and management has been established. The anticipated increase in air travel in the United States has made pavement management more critical as existing airport infrastructure is tasked with serving more flights. At issue is the ability of airport engineers to provide data to airport managers to maximize pavement use and optimize maintenance and repair funds. This report described the development of a FAA computer program to be used to evaluate and manage airport pavement.

This application will be developed using available existing standards for airport pavement maintenance and repair such as; applicable FAA Advisory Circulars, American Society for Testing and Materials (ASTM) standards, and federal Information Technology requirements.

2. AIRPORT PAVEMENT ROUGHNESS RESPONSE TESTS

2.1 Airport Pavement Roughness Background

This evaluation effort was undertaken in response to a memorandum direction from the Manager, Airport Technology Research and Development, AJP-6312, dated July 27, 2006. The memorandum requested that the Flight Standards Service – Flight Technologies and Procedures Division at the Mike Monroney Aeronautical Center (MMAC) begin work on the first phase of a project to study the subjective response of pilots to vibrations induced by airport pavement roughness in flight simulators. This project is required to establish acceptable and unacceptable limits of pavement roughness for in-service airport pavement. There are three phases for the work; input of known airport profiles into the simulator software, subjective evaluation of the profiles by flight crews using Human Factors methodology, and the correlation of the subjective evaluations to objective pavement profile indexes.

2.2 Airport Pavement Roughness Discussion

FAA Advisory Circular (AC) 150/5370-10C, Standards for Specifying Construction of Airports provides pavement smoothness acceptance standards for the construction of flexible and rigid pavements, reference [5]. Item P-401, Plant Mix Bituminous Pavements and Item P-501 Cement Concrete Pavement both refer to smoothness as an index for construction acceptance. Evaluating existing airport pavements for roughness has been more difficult; currently there is no industry standard that determines when an airport pavement is excessively rough. Using criteria for new construction is not applicable. The FAA and other organizations use several methods to evaluate and quantify airport pavement roughness. A partial list of methods include: the Boeing Bump, Bandpass Filters, International Roughness Index (IRI), etc. Pending an industry consensus on acceptable methods for evaluating existing pavement roughness, corrective actions on excessively rough pavement will continue to be initiated by pilot complaints.
Evaluation tasks to be accomplished within the framework of this effort are to be done in two separate phases. Phase 1 is the development of simulator models that are capable of accepting existing runway profiles that accurately recreate the vertical vibration environment experienced in the cockpit of an aircraft operating on the ground. Some of the challenges identified in phase 1 are; reconciling the onboard accelerometer values with the accelerations indicated from the pavement profiles and varying the amplitude of the accelerations with respect to the simulator ground speed. The profiles analyzed by the simulator have been sampled using four foot spacing. The simulation models will be based on longitudinal runway profiles provided by AJP-6312 and are to be loaded into the Boeing 737-800 simulator located at MMAC.

The first phase includes the following enhancements to the airport simulation software: creation of a pavement roughness profile control page, pavement profile input routines, and increasing the cockpit accelerometer sample rate to 60Hz. The enhanced software allows for the input of parameters such as groundspeed, runway distance, runway height, and accelerometer output.

Phase 2 of the evaluation contains several stages. The first stage is the development of a subjective pavement roughness rating scale for pilots. This scale will be created in conjunction with Human Factors specialists to create accurate testing and data capture from the flight crews. The simulated pavement roughness will vary from very smooth to unacceptably rough. Initially the test scenarios will be evaluated by FAA flight crews prior to testing by commercial pilots following a comprehensive test plan. The roughness simulation tests will include landings, takeoffs and ground movements. Subjective pilot response will be collected using post simulation test questionnaires designed to capture meaningful evaluations of the simulator tests. The larger scale testing will be done using Boeing 737 qualified flight crews (Captain and First Officer) operating on a combination of simulated airport pavements with ten movements each of landings, takeoffs, and taxiing.

The second stage will relate the pilots’ subjective responses to objective measures of airplane vertical acceleration and objective measures of pavement roughness computed from the simulated profiles. Finally, after the statistical interpretation and data analysis is completed; relate the pilots’ subjective response to corresponding objective values on airport roughness criteria such as the Boeing Bump, Bandpass Filters, IRI, ISO exposure criteria, etc. Accurately transforming the flight crew subjective responses via the questionnaires to objective values on pavement roughness criteria is the goal of the research.

2.3 Airport Pavement Roughness Conclusion

Procedures for determining the roughness of newly constructed airport pavement have been developed and accepted. Evaluating roughness and the development of an acceptable roughness standard during the in-service life of airport pavement has not been done.

This project will collect and analyze subjective flight crew data as they experience different levels of pavement roughness. After analysis, the data collected will be used to relate the subjective values to appropriate values of various airport pavement roughness criteria to be used as a method to determine when a pavement needs to be repaired or replaced.

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4. References


