ACRP Problem No.  12-04-12

Measuring Aircraft Landing Requirements on Contaminated Runways

ACRP Staff Comments: No comments offered.

TRB Aviation Group Committees Comments: AIRCRAFT/AIRPORT COMPATIBILITY
CMTE - Proper research in this area potentially will allow better information to be transmitted to pilots about runway braking conditions, enhancing safety in wet or icy conditions. It would be desirable to compare the BAT results to various existing devices. Information should also be obtained from pilots, black boxes, and airlines regarding the use of aircraft braking mechanisms/procedures.

Review Panel Comments: Recommended — The FAA is moving away from CFME to on-aircraft measurements (software updates) and is investigating the use of these new systems. But there is a CFME requirement coming out soon as discussed in a NPRM. Pilots do request Mu readings at some airports, and this is an opportunity to get pilot braking action measurements to be used prior to their landing and related to their type of aircraft. Airports can't control the information that they can give aircraft operators. This is applied differently at airports and has been inconsistent. The research could provide valuable information because the airport operator still has an obligation to measure and report. The more information airports can have the better. The problem statement is not clear, however, as to whether this is to fund just one product, but the project panel should ensure that the focus is on the use of other products.

AOC Disposition: No funds allocated. No discussion.
I. PROBLEM TITLE

Measuring Aircraft Landing Requirements on Contaminated Runways

Is this research idea in the FY 2011 Emphasis area (Maintenance and Operations)? YES

II. RESEARCH PROBLEM STATEMENT

Measuring the surface conditions of a runway and properly assessing the wheel-braking capability is crucial to the safe landing or take-off of an airplane, especially when the runway is ‘contaminated’ during heavy rain storms or during the winter season. The current practice to estimate the runway ‘breaking capability’ is to use current tire-road friction measurement devices that are usually of a fixed slip or skewed wheel type for Continuous Friction Measurement (CFMEs), or a decelerometer in a non-ABS or ABS-disabled vehicle. Although they provide some meaningful data of the runway surface condition, it has proven to be impossible to reliably correlate the outputs of these devices to the real braking performance of airplanes, especially on contaminated runways.

From the analysis of recent aircraft runway overrun accidents, it has been identified that the Anti-Skid Braking System (ASBS) used in current aircrafts can cause a significantly longer braking distance than is predicted by runway friction measure measurement devices due to the effect of deformable contaminants. However, none of the current commercially available friction measurement devices takes the aircraft ASBS into account in measuring the surface characteristics of a runway. From this perspective, the lack of an adequate runway condition reporting device substantiates the need to develop a new system that can more accurately predict the braking performance of an aircraft by mimicking its actual stopping characteristics as closely as possible. Therefore, this project will address two issues: 1) how to incorporate the ASBS functionality into the measurement of tire-runway braking characteristics, and 2) how to correlate the measured braking forces data to the actual braking distance of an aircraft.

The Braking Availability Tester (BAT) is being developed so that it is capable of mimicking the wheel braking characteristics of a (non-aerodynamically actively braked) braking aircraft and providing realistic values that can be used by pilots to predict the wheel-braking performance of their aircraft on a runway. From the mechanical engineering perspective, the basic structure of the machine is a measurement device with an instrumented measuring wheel integrated into a commercially available road vehicle. A hydraulically actuated wheel brake is being incorporated onto the aircraft tire measurement wheel along with the sensors and valves typical of an ASBS. The ASBS are being controlled by a dedicated controller. The forces induced by the ASBS are measured either with an axle torque transducer and/or load cell arrangement in the structure of the measuring wheel. The device also includes an algorithm(s) to take the data measured with the braking device and produce the estimated braking distances for landing/rejected take-off aircraft.
III. **OBJECTIVE**

The intent of this project will be to evaluate the estimated braking required to safely stop under contaminated surfaces. The study is expected to provide the aviation industry with the ability to predict the actual braking of aircrafts to ultimately improve safety significantly.

IV. **RESEARCH PROPOSED**

Preliminary BAT field testing has been carried out over a range of conditions. It would be desirable to compare the BAT results to various existing devices. As a minimum, the regular operational friction testing will be reviewed and compared with the BAT results. Friction measurements will be carried out in parallel with the BAT test. During the testing, all Pilot Reports (PIREPS) will be examined and observed landing distances will be recorded and compared. Information should also be obtained from Pilots and airlines regarding the use of aircraft braking mechanisms/procedures. Whenever possible, information from the black box information from aircrafts will be extracted and documented. In addition, it would be proposed that a video would be taken of each BAT test and each applicable aircraft movement.

Phase 1 testing will be carried out at the Center for Pavement and Transportation Technology Test Track in Waterloo, Ontario. This is a road testing facility where the device can be initially tested to ensure it is safe and appropriate for testing on an active airfield. Once this preliminary testing has been satisfactorily carried out, airfield testing is to be carried out at the Region of Waterloo International Airport. Testing at the Waterloo Airport is intended to encompass a variety of pavement contaminant conditions and temperature ranges. It should be noted that field testing will largely depend on the available environmental conditions. Every effort will be made to test and document the BAT device over a realistic operational range. Any required modification and adjustments would be addressed and a more robust technology/device would be in-service in Winter 2011/12.

V. **ESTIMATE OF THE PROBLEM FUNDING AND RESEARCH PERIOD**

**RECOMMENDED FUNDING:**
The estimated funding required for this project is $200,000 per year for two years. This funding will be applied towards the construction, maintenance and operation costs associated with building the BAT, and towards funding tests to validate the reliability of the BAT.

**RESEARCH PERIOD:**
Two years, including 3 months for review and revision of a draft final report.

VI. **URGENCY AND PAYOFF POTENTIAL**

This work is very timely, given the need to ensure safety on international airport pavements. The need to effectively quantify in-situ conditions and provide that information in real-time to pilots, airlines and airport operators is critical. If airports are going to realize effective in-service monitoring of runway conditions, it is paramount that there is a fundamental understanding of all the components that impact the aircraft braking availability. The BAT and results from the research program could provide support to the FAA, Transport Canada, ICAO, the CAA and the airport community at large throughout the world. Airlines, pilots, airport operators, airport
managers and policy makers will also benefit from this research through improved safety, dispatch decision making and more accurate monitoring of in-situ conditions. Technical reports on the development of the BAT will be created, along with recommended practices for the correct usage of this device, as they become available.

VII. RELATED RESEARCH

It is our understanding that the BAT is the first device of its kind being developed to incorporate field testing and in-situ conditions to estimate braking characteristics of non-aerodynamically braking aircrafts.

VIII. PERSON(S) DEVELOPING THE PROBLEM

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IX. PROCESS USED TO DEVELOP PROBLEM STATEMENT

The need for measuring the surface conditions of a runway and properly assessing the wheel-braking capability of aircrafts was identified from the analysis of recent aircraft runway overrun accidents. The BAT is a solution proposed and being developed by Team Eagle Ltd., in cooperation with the University of Waterloo.

X. DATE AND SUBMITTED BY

Submitted March 4, 2011
Submitted by Susan Tighe, PhD, PEng