Airfield and Highway Pavements 2017

Design, Construction, Evaluation, and Management of Pavements

Selected Papers from the Proceedings of the International Conference on Highway Pavements and Airfield Technology 2017

Edited by

Imad L. Al-Qadi, Ph.D., P.E.
Hasan Ozer, Ph.D.
Eileen M. Vélez-Vega, P.E.
Scott Murrell, P.E.

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Preface

An ever-growing number of highway and airport agencies, companies, organizations, institutes, and governing bodies are embracing principles of sustainability in managing their activities and conducting business. Overarching goals emphasize key environmental, social, economic, and safety factors in the decision-making process for every pavement project. Therefore, the theme of the conference was chosen as “Sustainable Pavements and Safe Airports.” It is dedicated to the state-of-the-art and state-of-practice areas durability, cost-effective, and sustainable airfield and highway pavements. In addition, recent advancements and technologies to ensure safe and efficient airport operations are included.

This international conference provides a chance to interact and exchange information with worldwide leaders in the fields of highway and airport pavements, as well as airport safety technologies. This conference brought together researchers in transportation and airport safety technologies, designers, project/construction managers, academics, and contractors from around the world to discuss design, implementation, construction, rehabilitation alternatives, and instrumentation and sensing.

The proceedings of 2017 International Conference on Highway Pavements and Airfield Technology have been organized in four (4) publications as follows:

Airfield and Highway Pavements 2017: Design, Construction, Evaluation, and Management of Pavements
This volume includes papers in the areas of mechanistic-empirical design methods and advanced modeling techniques for design of conventional and permeable pavements, construction specifications and quality, accelerated pavement testing, pavement condition evaluation, and network level management of pavements.

Airfield and Highway Pavements 2017: Testing and Characterization of Bound and Unbound Pavement Materials
This volume includes papers in the areas of laboratory and field characterization of asphalt binders, asphalt mixtures, base/subgrade materials, and recent advances in concrete pavement technology. This volume also features papers for the use of recycled materials, in-place recycling techniques and unbound layer stabilization methods.

Airfield and Highway Pavements 2017: Pavement Innovation and Sustainability
This volume is dedicated to the papers featuring most recent technologies used for structural health monitoring of highway pavements, intelligent compaction, and innovative technologies used in the design and construction of highway pavements. The volume also includes papers in the area of sustainability assessment using life-cycle assessment of highway and airfield pavements and climate change impacts and preparation for pavement infrastructure.

Airfield and Highway Pavements 2017: Airfield Pavement Technology and Safety
This volume is dedicated to recent advances in the area of airfield pavement design technology and specifications, modeling of airfield pavements, use of accelerated loading systems for airfield pavements, and airfield pavement condition evaluation and asset management.

The papers in these proceedings are the result of peer reviews by a scientific committee of more than 90 international pavement and airport technology experts, with three to five reviewers per paper. Recent research was presented in the technical podium and poster sessions including the results from current Federal Aviation Administration (FAA) airport design, specifications, and safety technologies; design and construction of highway pavements; pavement materials characterization and modeling; pavement management systems; and innovative technologies and sustainability. The plenary sessions featured the Francis Turner Lecture by Dr. Robert Lytton and the Carl Monismith Lecture by Dr. David Anderson. In addition, two technical tours were offered: Philadelphia International Airport and the Center for Research and Education in Advanced Transportation Engineering Systems (CREATEs) Lab of the Henry M. Rowan College of Engineering at Rowan University.

Three workshops were presented prior to the conference: hands-on FAA's FAARFIELD software, design and construction of permeable pavements, and environmental product declarations.

The editors would like to thank the members of the scientific committee who volunteered their time to review the submitted papers and offered constructive critiques to the authors. We are also grateful for the work of the steering committee members in planning and organizing the conference: Katie Chou, Jeffrey Gagnon, John Harvey, Brian McKeehan, Shiraz Tayabji, and Geoffrey Rowe; as well as the local organizing committee chaired by Geoffrey Rowe and members including James A. McKelvey, Timothy Ward, Ahmed Faheem, and Yusuf Mehta for their help with the technical tours. Finally, we would like to especially thank the ASCE T&DI staff who helped put the conference together: Muhammad Amer, Mark Gable, Drew Caracciolo, and Deborah Denney.

Imad L. Al-Qadi, Ph.D., P.E., Dist. M.ASCE, University of Illinois at Urbana-Champaign
Hasan Ozer, Ph.D., M.ASCE, University of Illinois at Urbana-Champaign
Eileen M. Vélez-Vega, P.E., M.ASCE, Kimley-Horn Puerto Rico, LLC
Scott D. Murrell, P.E., M.ASCE, Applied Research Associates

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Comparing Methods for Determining In Situ Asphalt Stiffness Using Pavement ME

N. D. Bech[1]; J. M. Vandenbossche[2], Ph.D., P.E.; A. Mateos[3]; and J. T. Harvey, Ph.D., P.E.[4]

[1]Dept. of Civil and Environmental Engineering, Univ. of Pittsburgh, 713 Benedum Hall, 3700 O'Hara St., Pittsburgh, PA 15261. E-mail: ndb39@pitt.edu
[2]Dept. of Civil and Environmental Engineering, Univ. of Pittsburgh, 705 Benedum Hall, 3700 O'Hara St., Pittsburgh, PA 15261. E-mail: jmv7@pitt.edu
[3]Pavement Research Center, 1353 South 46th St., Building 480, Richmond, CA 94804. E-mail: angel-mateos@berkeley.edu
[4]Dept. of Civil and Environmental Engineering, Univ. of California, Davis, 3153 Ghausi Hall, One Shields Ave., Davis, CA 95616. E-mail: jtharvey@ucdavis.edu

Abstract

The in-situ asphalt stiffness master curve is a critical input for flexible pavement design. The master curve can be established directly by performing dynamic modulus testing on field cores, predicted using the volumetrics of the mixture, binder grade and aggregate gradation established using field cores, or backcalculated using falling weight deflectometer testing. There can be significant differences between the master curves established using these three different methods. The effects of these differences on design were compared using distress predicted by the asphalt pavement design module in Pavement ME. It was found that the method used to determine the in-situ asphalt stiffness can have a significant effect on the predicted distress.

Introduction

There are three primary methods for determining the in-situ stiffness of the asphalt for an in-service pavement. A master curve that describes the dynamic modulus of the asphalt concrete as a function of load frequency and temperature can be developed using data from dynamic modulus testing performed on cores pulled from the pavement (AASHTO T 342). A dynamic modulus master curve can also be estimated based on the volumetrics, gradation, and binder grade of the asphalt mixture using a predictive equation, such as the Witczak, Hirsch, or Al-Khateeb equations (Andrei, et al., 1999, Bari, 2005, Christensen, et al., 2003, Al-Khateeb, et al, 2006). Artificial neural networks have also been used to predict dynamic modulus from asphalt mixture parameters (Ceylan, et al., 2007, Kim, et al., 2015). Finally, the modulus can be backcalculated using falling weight deflectometer (FWD) data.

Differences between the three methods for determining in-situ asphalt stiffness were evaluated using data collected at the Minnesota Road Research Facility (MnROAD). Asphalt concrete cores were pulled and dynamic modulus tests were performed to establish master curves. Additional cores were taken and their volumetric parameters were used to estimate dynamic modulus master curves using the Witczak equation. Finally, moduli backcalculated from FWD testing were used to estimate dynamic modulus master curves. The effect of the difference in the estimated moduli on predicted performance was then evaluated using Pavement ME.

Background

Each of the three approaches for establishing the in-situ asphalt stiffness has advantages and disadvantages. Performing dynamic modulus testing on cores pulled from the in-service pavement (AASHTO T 342) is the best means for measuring the "true" asphalt stiffness over a range of temperatures and frequencies. However, it is very expensive and time consuming to perform. Also, dynamic modulus test specimens are only 151 mm thick, so the entire thickness of the asphalt layer is not tested if it is greater than 151 mm thick.

The use of predictive equations, such as the Witczak or Hirsch equations, is a more cost effective method for establishing the dynamic modulus. The Witczak equation is based on two volumetric parameters of the asphalt mixture (percent air voids (V_a), and volumetric effective binder content (V_{be})), the characteristics of the aggregate gradation (P_{38}, P_{34}, P_4, and P_{200}), and the binder grade (Andrei et al., 1999). These parameters can be determined from destructive testing of field cores or historic mixture design information. Predictive models, however, do not provide an exact measure of the dynamic modulus. The Witczak equation was developed using lab-mixed, lab-compacted, undamaged asphalt specimens. Additionally, many of the dynamic modulus tests used to fit the Witczak model were performed diametrically, whereas the current dynamic modulus test (AASHTO T342) uses axial loading (Andrei, et al., 1999). All of these factors can contribute to a difference between the dynamic modulus predicted using the Witczak equation and the dynamic modulus measured in the lab. It is worth noting that even if the use of the Witczak equation does not provide a "true measure" of the dynamic modulus, it is possible that this method provides the most realistic predicted pavement thicknesses when using Pavement ME for design. This is because the calibration of the performance prediction curves was performed using dynamic moduli established primarily using the Witczak equation (ARA, 2004).

The stiffness of the asphalt can also be backcalulated from FWD data. This stiffness corresponds to the temperature of the asphalt at the time the FWD testing is performed and to the load frequency of the FWD. Moduli backcalculated from deflection data collected when the asphalt pavement is at different temperatures can be used to "calibrate" a master curve developed using the Witczak equation. First, the Witczak equation and the measured volumetric and aggregate properties of the asphalt mix are used to construct a dynamic modulus master curve that describes the asphalt stiffness as a function of load frequency and temperature. This master curve is then used to determine the dynamic modulus at the temperature of the asphalt layer when the FWD testing was performed. Finally, the load frequency can be established