Airfield and Highway Pavements 2017

Pavement Innovation and Sustainability

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.

ASCE

T&DI ASCE TRANSPORTATION & DEVELOPMENT INSTITUTE

This is a preview. Click here to purchase the full publication.

AIRFIELD AND HIGHWAY PAVEMENTS 2017

PAVEMENT INNOVATION AND SUSTAINABILITY

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON
HIGHWAY PAVEMENTS AND AIRFIELD TECHNOLOGY 2017

August 27–30, 2017
Philadelphia, Pennsylvania

SPONSORED BY
The Transportation & Development Institute
of the American Society of Civil Engineers

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

Published by the American Society of Civil Engineers

This is a preview. Click here to purchase the full publication.

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia, 20191-4382
www.asce.org/publications | ascelibrary.org

Any statements expressed in these materials are those of the individual authors and do not necessarily represent the views of ASCE, which takes no responsibility for any statement made herein. No reference made in this publication to any specific method, product, process, or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASCE. The materials are for general information only and do not represent a standard of ASCE, nor are they intended as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document. ASCE makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefor. The information contained in these materials should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing such information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

Photocopies and permissions. Permission to photocopy or reproduce material from ASCE publications can be requested by sending an e-mail to permissions@asce.org or by locating a title in ASCE's Civil Engineering Database (http://cedb.asce.org) or ASCE Library (http://ascelibrary.org) and using the "Permissions" link.

Errata: Errata, if any, can be found at https://doi.org/10.1061/9780784480946

Copyright © 2017 by the American Society of Civil Engineers.
All Rights Reserved.
ISBN 978-0-7844-8094-6 (PDF)
Manufactured in the United States of America.

This is a preview. Click here to purchase the full publication.

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.

© ASCE

This is a preview. Click here to purchase the full publication.

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

© ASCE

This is a preview. Click here to purchase the full publication.

Contents

© ASCE

This is a preview. Click here to purchase the full publication.

© ASCE

This is a preview. Click here to purchase the full publication.

Next Generation Structural Health Monitoring of Highway/Airfield Pavements

Winter Maintenance of Pavements—Use of Innovative Techniques and Materials

© ASCE

This is a preview. Click here to purchase the full publication.

Configuration of Electrodes for Electrically Conductive Concrete Heated Pavement Systems

Hesham Abdualla[1]; Halil Ceylan[2]; Sunghwan Kim[3]; Mani Mina[4]; Kasthurirangan Gopalakrishnan[5]; Alireza Sassani[5]; Peter C. Taylor[6]; and Kristen S. Cetin[7]

[1]Graduate Research Student, Iowa State Univ. E-mail: abdualla@iastate.edu
[2]Professor, Iowa State Univ. E-mail: hceylan@iastate.edu (Corresponding Author)
[3]Research Scientist, Iowa State Univ. E-mail: sunghwan@iastate.edu
[4]Associate Professor, Iowa State Univ. E-mail: mmina@iastate.edu
[5]Research Associate Professor, Iowa State Univ. E-mail: rangan@iastate.edu
[5]Graduate Research Student, Iowa State Univ. E-mail: asassani@iastate.edu
[6]Director, National Concrete Pavement Technology Center. E-mail: ptaylor@iastate.edu
[7]Assistant Professor, Iowa State Univ. E-mail: kcetin@iastate.edu

ABSTRACT

This study investigates the effects of the type and configuration of embedded electrodes on resistive heating performance of an electrically conductive concrete (ECON) heated-pavement system (HPS). Three ECON slabs – an ECON slab with perforated galvanized steel angle electrodes, an ECON slab with steel rebar electrodes, and an ECON slab with perforated galvanized steel angle electrodes with an isolation layer – were designed and constructed. The resistive heating performance of the slabs was evaluated by measuring the electric current and ECON slab surface temperature at specific points during the application of voltage. The results revealed that the performance of the ECON slab with perforated galvanized steel angle electrodes was marginally changed when an isolation layer was used, so with respect to construction practice and cost considerations, an isolation layer is not deemed to be necessary for constructing large-scale ECON heated pavements. Electrical current measurements can be used for evaluating the conductivity and the heating capability of the ECON slabs.

INTRODUCTION

Electrically conductive concrete (ECON) heated pavement systems (HPS) have increasingly gained attention due to their potential for melting ice and snow while overcoming the drawbacks of using traditional deicing methods (Xi and Patricia 2000; Arabzadeh et al. 2016a and b; Arabzadeh et al. 2017; Ceylan et al. 2014). ECON is a versatile material that can be used as a resistive heating medium for

© ASCE

This is a preview. Click here to purchase the full publication.

construction of self-heating pavement systems (Sassani et al. 2017). ECON HPS works by applying a voltage to electrodes embedded in the ECON layer to deliver power to conductive materials and thereby melt ice and snow (Abdualla et al. 2016). Electrodes are the ECON HPS components that conduct electric current from an electrical power supply into the ECON to heat up the ECON surface. In general, electrodes made of metallic materials are capable of allowing current flow into the ECON layer since their conductivities are higher than the ECON itself.

Sufficient bonding between the electrodes and the ECON matrix is crucial to achieving resistive heating performance (Zuofu et al. 2006; Chen and Ping 2012; Tian and Hu 2012). The use of copper mesh and steel mesh as embedded electrodes in the ECON layer has been shown to transfer sufficient current into the ECON layer (Gopalakrishnan et al. 2015; Wu et al. 2013). Steel plate electrode has been associated with inadequate performance on heating tests because of poor electrode-concrete bonding (Tuan 2004). Use of perforated galvanized stainless steel with hole size larger than the maximum aggregate size has been recommended as a satisfactory method for achieving interlocking between the ECON matrix and the electrodes (Ceylan 2015), but there are also limited studies in the existing literature investigating the effects of embedded electrode arrangement in achieving efficient heating performance of ECON HPS.

This study investigates the effect of electrode configuration on heating performance of ECON HPS. To this end, ECON slabs with different embedded electrode types and configurations were prepared and tested to evaluate their electrical heating performance. The experimental parameters reflecting the heating performance of ECON slabs were temperature and electrical current readings. The outcome of this study is expected to provide guidance on electrode design for large-scale ECON slab design and construction.

METHODOLOGY

Three prototype ECON slabs (95 cm long × 35 cm wide × 7 cm thick) with various sets of electrode types, shapes, and configurations were designed and constructed at the ISU Portland Cement Pavement and Materials Research Laboratory. These units included: (1) a prototype ECON slab with perforated galvanized steel angle electrodes, (2) a prototype ECON slab with steel rebar electrodes, and (3) a prototype ECON slab with perforated galvanized steel angle electrodes and an isolation layer.

Figure 1 depicts the ECON slab with four perforated galvanized steel angle electrodes (3.8 cm long x 3.8 cm wide x 0.3 cm thick). Electrodes were first placed inside the formwork as shown in Figure 1(a), and the ECON mix was then poured into the slab formwork (Figure 1(b)). The ECON mix contained 0.75 % (by total volume of concrete) of 6-mm-long carbon fiber. The detailed ECON mix proportion has been presented and discussed in previous studies (Sassani et al. 2015; Abdualla et al. 2016)

Concrete vibration was used to improve the bond between electrodes and the ECON mix. The slab was constructed with a 7.6 cm-thick layer of ECON. The ECON resistivity value was 400 Ω·cm.

© ASCE

This is a preview. Click here to purchase the full publication.