GEOTECHNICAL SPECIAL PUBLICATION NO. 239

PAVEMENT MATERIALS, STRUCTURES, AND PERFORMANCE

SELECTED PAPERS FROM THE PROCEEDINGS OF THE 2014 GEOSHANGHAI INTERNATIONAL CONGRESS

May 26-28, 2014
Shanghai, China

SPONSORED BY
The Geo-Institute of the American Society of Civil Engineers

EDITED BY
Baoshan Huang
Sheng Zhao

Published by the American Society of Civil Engineers

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

Errata: Errata, if any, can be found at http://dx.doi.org/10.1061/9780784413418

ISBN 978-0-7844-1337-1 (CD)
ISBN 978-0-7844-1341-8 (E-book PDF)
Manufactured in the United States of America.

Preface

A variety of topics in pavement structure and materials were covered in this special publication that contains 42 technical papers. The selected papers were organized into three technical sections: (1) Paving Materials Characterization and Modeling; (2) Pavement Evaluation, Analysis and Construction; and (3) Pavement Base and Subgrade. The materials presented in *Paving Materials Characterization and Modeling* section include aggregates, asphalt binder, hot mix asphalt (HMA), warm mix asphalt (WMA), recycled asphalt pavement (RAP), recycled asphalt shingles (RAS), and asphalt binder additives and fillers. Some new technologies include microwave heating, 3D surface roughness measurements and nano-technology. The *Pavement Evaluation, Analysis and Construction* section covers pavement field evaluation, structural analysis, as well as the construction technologies for asphalt pavement and concrete pavement. Several models are introduced to analyze and predict major pavement distresses. Pavement preservation technologies are also covered in this section. In the *Pavement Base and Subgrade* section, the papers concentrate on characterization and performance prediction of subgrade soils and other treated base materials used for pavement construction.

Each paper was reviewed by two or more reviewers as well as the editors prior to being published in this ASCE Geotechnical Special Publication (GSP). The authors were required to address the reviewers' comments until the paper met the satisfaction of the editors. All published papers are eligible for discussion in the Journal of Geotechnical and Geoenvironmental Engineering, Journal of Materials in Civil Engineering, and are also eligible for ASCE awards.

The papers collected in this publication were presented during GeoShanghai 2014 International Conference held in Shanghai, China, May 26-28, 2014. The conference was chaired by Professor Wenqi Ding and co-chaired by Professor Lianyang Zhang. The organizations that hosted this conference include Tongji University, the Chinese Institution of Soil Mechanics and Geotechnical Engineering, the Chinese Society for Rock Mechanics and Engineering and the Shanghai Society of Civil Engineering in cooperation with ASCE Geo-Institute, the International Society for Soil Mechanics and Geotechnical Engineering, the International Association of Chinese Infrastructure Professionals, the Deep Foundations Institute in the USA, the Alaska University Transportation Center (USA), University of Edinburgh (UK), Ruhr University Bochum (Germany), University of Cambridge (UK), Ecole des Ponts Paristech (France), Virginia Polytechnic Institute and State University (USA), the Shanghai Society of Theoretical and Applied Mechanics, Nagoya Institute of Technology (Japan), University of Arizona (USA), the Transportation Research Board (TRB) (USA), University of Kansas (USA), Georgia Institute of Technology (USA), Vienna University of Natural Resources and Applied Life Sciences (Austria), and University of Tennessee (USA).

Editors:

Baoshan Huang, Ph.D., P.E., and Sheng Zhao

The University of Tennessee, Knoxville, TN

January 22, 2014

Acknowledgements

The editors would like to appreciate the organizing committee providing technological support in administrating the paper submission. Thanks are extended to Donna Dickert of ASCE, Robert Schweinfurth of ASCE Geo-Institute (G-I) and ASCE Construction Institute (CI). Special thanks are given to the following individuals that provided timely and high-quality technical reviews for one or more papers submitted to this conference:

Name	**Orgazation**	**Country**
Benjamin F. Bowers	University of Tennessee	USA
Zhigang Cao	Zhejiang University	China
Xingwei Chen	Louisiana Department of Transportation and Development	USA
Lin Cong	Tongji University	China
Shongtao Dai	Minnesota Department of Transportation	USA
Qiao Dong	Tennessee Department of Transportation	USA
Hongren Gong	University of Tennessee	USA
Wei Hu	University of Tennessee	USA
Baoshan Huang	University of Tennessee	USA
Jagada Jha	Guru Nanak Dev Engineering College	India
Xiaoyang Jia	University of Tennessee	USA
Ximiao Jiang	Federal Highway Administration	USA
Marta Kadela	Dr Eng. Building Research Institute	Poland
Zhen Leng	Hong Kong Polytechnic University	China
Peng Li	Chang'an University	China
Xinjun Li	Federal Highway Administration	USA
Juanyu Liu	University of Alaska	USA
Louay N. Mohammad	Louisiana Transportation Research Center	USA
Andre A.A. Molenaar	Delft University of Technology	The Netherlands

Mbakisya A. Onyango	University of Tennessee at Chattanooga	USA
Jinsong Qian	Tongji University	China
Tyler Rutherford	University of Tennessee	USA
Cedric Sauzeat	University of Lyon/ENTPE, LGCB & LTDS	France
A U Ravi Shankar	NITK Surathkal, Srinivasnagar Post Karnataka	India
Xiang Shu	University of Tennessee	USA
Weimin Song	University of Tennessee	USA
Hao Wang	The State University of New Jersey	USA
Zhenjun Wang	Chang'an University	China
Hao Wu	Central South University	China
Feipeng Xiao	Wuhan University of Technology	China
Henglong Zhang	Hunan University	China
Hongduo Zhao	Tongji University	China
Sheng Zhao	University of Tennessee	USA
Changjun Zhou	University of Tennessee	USA
Fujie Zhou	Texas A&M Transportation Institute	USA
Yumin Zhou	Tongji University	China

GSP 239 Table of Contents

Paving Materials Characterization and Modeling

Pavement Evaluation, Analysis, and Construction

Pavement Base and Subgrade

Laboratory Preparation and Microwave Heating Test of CIPs/Asphalt Binder

Zhenjun Wang[1], Sheng Wang[2], Tao Ai[3] and Peng Zhao[4]

[1]Associate professor, School of Materials Science and Engineering, Chang'an University, Xi'an 710061, P.R. China; wangzhenjun029@163.com

[2]Postgraduate, School of Materials Science and Engineering, Chang'an University, Xi'an 710061, P.R. China; wzjolan@163.com

[3]Associate professor, School of Materials Science and Engineering, Chang'an University, Xi'an 710061, P.R. China; aitao@chd.edu.cn

[4]Professor, School of Materials Science and Engineering, Chang'an University, Xi'an 710061, P.R. China; zyzhaop@chd.edu.cn

ABSTRACT: Microwave heating technology has been adopted in asphalt pavement maintenance to reduce the total cost resulting from the energy consumption. In this paper, laboratory preparation and microwave heating test of carbonyl iron powders (CIPs)/asphalt binder were carried out. The modeling procedure, microwave heating efficiency and the properties of the CIPs/asphalt binder, such as penetration, softening point and ductility, were studied. The results show that microwave heating efficiency of CIPs/asphalt binder is enormously higher than that of ordinary asphalt binder. Adding a certain amount of CIPs can improve the asphalt binder's resistance to deformation at high temperature. All these can put forward a theoretical basis to design asphalt mixtures being suitable to be used in snow and ice removal by microwave pavement maintenance vehicles.

INTRODUCTION

As to the problem that conventional heating methods requires that the energy propagates through the asphalt materials by diffusion, power microwave was adopted to heat asphalt binder with CIPs by its microwave absorbing characteristics at different frequencies (Zivkovic et al. 2012). Microwave heating is a relatively new technology, which provides alternative approaches for enhancing material properties (Chun et al. 2013). There had been many studies on the construction and evaluation of asphalt mixes pavement with microwave technology. For example, Jaselskis et al. (2001) measured the density of asphalt in real time using a differential microwave signal approach. Sun et al. (2008) built a two-dimensional heat transfer model for the asphalt mixtures within the heating range based on the theory of unsteady heat conduction to solve for temperature fields in microwave heating for recycling asphalt mixtures. Meanwhile, a volume