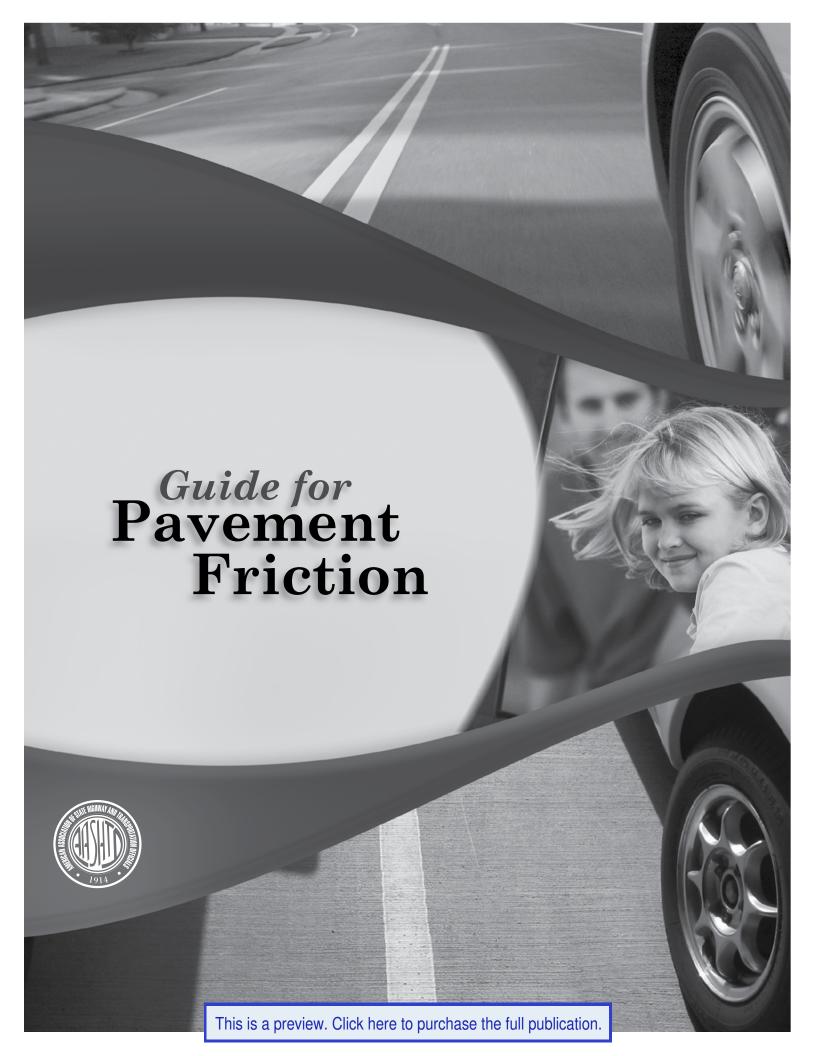


© 2008, by American Association of State Highway and Transportation Officials. All rights reserved. This book, or parts thereof, may not be reproduced in any form without written permission of the publisher. Printed in the United States of America.		
ISBN: 978-1-56051-428-2	Pub Code: GPVF-1	

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



2007-2008

Joint Technical Committee on Pavements

Chair

Dan Dawood Pennsylvania

Region 1

Delaware

Robin Davis (Design)

Maryland

Tim Smith (Materials)

New York

Wes Yang (Design)

Vermont

Michael Pologruto (Design)

Vacant (Design)

Region 2

Alabama

Larry Lockett (Materials)

Arkansas

Phillip McConnell (Design)

Louisiana

Jeff Lambert (Design)

North Carolina

Judith Corley-Lay (Design)

South Carolina

Andy Johnson (Design)

Region 3

Iowa

Chris Brakke (Design)

Kansas

Andy Gisi (Design)

Minnesota

Curt Turgeon (Materials)

Missouri

Jay F. Bledsoe (Design)

Ohio

Aric Morse (Design)

Region 4

California

Bill Farnbach (Design)

Colorado

Richard Zamora (Design)

Oklahoma

Jeff Dean (Design)

Wyoming

Rick Harvey (Materials)

Vacant (Design)

Vice Chair

Linda Pierce Washington

Other

AASHTO Liaison Keith Platte and Ken Kobetsky

Standing Committee on Aviation Gary Harris, IA

FHWA

Pete Stephanos

Port Authority of

New York and New Jersey

Vacant

TRB

Amir Hanna



Table of Contents

List of Figures	iv
List of Tables	v
Acknowledgments	vi
Abstract	vi
1.0 Introduction 1.1 Background 1.2 Purpose and Scope of Guide 1.3 Guide Organization and Use	1
2.0 Pavement Friction Overview 2.1 Importance of Pavement Friction 2.2 Pavement Friction Principles	3
3.0 Pavement Friction Management	22
4.0 Pavement Friction Design 4.1 Introduction	37 37
References	61
Appendix A. Terminology	67
Appendix B. Standards Relevant to Pavement Friction	73
Annandiy C. Index of Standards and Test Methods	77

List of Figures

Figure 2-1.	Total Crashes (from All Vehicle Types) on U.S. Highways from 1988 to 2003 (NHTSA, 2004)
Figure 2-2.	Total Fatalities and Injuries (from All Vehicle Types) on U.S. Highways from 1988 to 2003 (NHTSA, 2004)
Figure 2-3.	Relationship between Wet-Weather Crash Rates and Pavement Friction (Rizenbergs et al., 1973)
Figure 2-4.	Mean Crash Risk for Roadway Network in the United Kingdom (Viner et al., 2004)
Figure 2-5.	Simplified Diagram of Forces Acting on a Rotating Wheel
Figure 2-6.	Pavement Longitudinal Friction Versus Tire Slip (Henry, 2000)
Figure 2-7.	Dynamics of a Vehicle Traveling around a Constant Radius Curve at a Constant Speed, and the Forces Acting on the Rotating Wheel
Figure 2-8.	Key Mechanisms of Pavement-Tire Friction
Figure 2-9.	Simplified Illustration of the Various Texture Ranges that Exist for a Given Pavement Surface (Sandburg, 1998)
Figure 2-10.	Texture Wavelength Influence on Pavement–Tire Interactions (adapted from Henry, 2000 and Sandburg and Ejsmont, 2002)
Figure 2-11.	The IFI and Rado IFI Models (Rado, 1994)
Figure 3-1.	Example of a Possible PFM Program
Figure 3-2.	Conceptual Relationship between Friction Demand, Speed, and Friction Availability
Figure 3-3.	Setting of Investigatory and Intervention Levels for a Specific Friction Demand Category Using Time History of Pavement Friction
Figure 3-4.	Setting of Investigatory and Intervention Levels for a Specific Friction Demand Category Using Time History of Friction and Crash Rate
Figure 3-5.	Setting of Investigatory and Intervention Levels for a Specific Friction Demand Category Using Pavement Friction Distribution and Crash Rate—Friction Trend
Figure 3-6.	Determination of Friction and/or Texture Deficiencies Using the IFI 34
Figure 4-1.	Example Illustration of Matching Aggregate Sources and Mix Types/texturing Techniques to Meet Friction Demand
Figure 4-2.	Example of Determining <i>DFT(20)</i> and <i>MPD</i> Needed to Achieve Design Friction Level
Figure 4-3.	Flowchart Illustration of Asphalt Pavement Friction Design Methodology (Sullivan, 2005)
Figure 4-4.	Illustration of Vehicle Response at 80 kph (50 mph) as Function of PSV and MPD (Sullivan, 2005)

List of Tables

Table 2-1.	Factors Affecting Available Pavement Friction (Wallman and Astrom, 2001) 10
Table 3-1.	Summary of Issues Relating to Standardized Test Conditions
Table 4-1.	Test Methods for Characterizing Aggregate Frictional Properties 39–42
Table 4-2.	Typical Range of Test Values for Aggregate Properties
Table 4-3.	Asphalt Pavement Surface Mix Types and Texturing Techniques 47–48
Table 4-4.	Concrete Pavement Surface Mix Types and Texturing Techniques 49–50
Table 4-5.	Pairs of MPD and DFT(20) Needed to Achieve Design Friction Level of 40 54

Acknowledgments

The research described herein was performed under NCHRP Project 1-43 by the Transportation Sector of Applied Research Associates (ARA), Inc. Dr. Jim W. Hall, Jr., was the principal investigator for the study.

Dr. Hall was supported in the research and in developing this guide by ARA research engineers Leslie Titus-Glover, Kelly Smith, and Lynn Evans, and by three project consultants—Dr. James Wambold (President of CDRM, Inc. and Professor Emeritus of Mechanical Engineering at Penn State University), Thomas Yager (Senior Research Engineer at the NASA Langley Research Center), and Zoltan Rado (Senior Research Associate at the Pennsylvania Transportation Institute).

The authors gratefully acknowledge all of the individuals with state departments of transportation (DOTs) who responded to the pavement friction survey conducted for this project. The authors also express their gratitude for the valuable input provided by knowledgeable representatives of DOTs, paving associations, academia, and manufacturers of friction measuring equipment, vehicle tires, and trucks.

Abstract

This report contains guidelines and recommendations for managing and designing for friction on highway pavements. The contents of this report will be of interest to highway materials, construction, pavement management, safety, design, and research engineers, as well as others concerned with the friction and related surface characteristics of highway pavements.

Information is presented that emphasizes the importance of providing adequate levels of friction for the safety of highway users. The factors that influence friction and the concepts of how friction is determined (based on measurements of surface micro-texture and macro-texture) are discussed. Methods for monitoring the friction of in-service pavements and determining appropriate actions in the case of friction deficiencies (friction management) are described. Also, aggregate tests and criteria that help attain adequate micro-texture are presented, followed by a discussion of how paving mixtures and surface texturing techniques can be selected so as to impart the macro-texture required to achieve the design friction level.