AASHTO Subcommittee on Materials
101st Annual Meeting – Pittsburgh, Pennsylvania

Technical Section 5a
Pavement Measurement Technologies
Annual Meeting

3:00 pm EST, Tuesday, August 4, 2015

Annual Meeting Agenda

I. Call to Order/Opening Remarks/General Business
   A. Call to Order –3:00 pm – Mullis, OR

II. Roster
   A. Introduction of members and guests
      i. Voting members present 14, and total present 40. (quorum = members present at TS meeting) TS 5a has 21 voting members.
   B. Prospective new members and changes in membership
      i. Cole Mullis, Oregon DOT is Chair, Andy Mergenmeier, FHWA, is Vice Chair and is the FHWA voting member
      ii. Any new members – Friends of Committee (can include industry and academia) – request Chair to become Friend of Committee and reason why.
   C. Standard Stewards (Appendix C)

III. Approve July 2014 Technical Section annual meeting minutes:

Motion by – CO | Second by - MN
Vote for - all | Vote against - none

IV. Old Business

A. 2014 SOM Ballot Item (Nov 2014-Jan 2015)

Ballot Name:	SOM 2014 Ballot
Ballot Number	
Ballot Start Date:	11/17/2014
Ballot Due Date:	1/9/2015
Item Number	**105**
Description	SOM ballot item to revise TP 76, Measurement of Tire/Pavement Noise Using the On-Board Sound Intensity (OBSI) Method, See pages 11-28 of the minutes.
Affirmative 44 / 52. Negative 1 / 52. No Vote 7 / 52.	
Virginia Department of Transportation (Charles A. Babish) (andy.babish@vdot.virginia.gov)	Yes but consider having an individual tread depth requirement to aide in determination of uneven or excess tread wear as stated in 6.3.4. Currently, A2.2.4 states that when the average tread depth is less than 0.28 in., do not use the tire. Will the average tell if the tire is wearing unevenly or is it expected that this will be based on a visual review?

	Currently, ASTM F2493 - 14 states that the groove depth shall be a minimum of 0.314 in. for each groove. Seems that a specific tolerance for each groove from the minimum could be specified and then compared to each other to see how close they are and determine acceptability of wear. **Response: This ASTM standard is referenced in TP 76. Change made in A2.2.4 to read: "A groove depth is less than 0.314 in. (7.97mm)" – as this corresponds to the current version of the ASTM F2493-14.**
Arizona Department of Transportation (Paul Burch) (pburch@azdot.gov)	1) The following content on defining uncertainty which is given in Chapter 5 of NCHRP Report 1-44 should be incorporated into this standard: "The approach to assessing uncertainty in experimental data used in this analysis is based on the international standard ISO 5725[32,33]. Based on these references, the uncertainty and the limit of repeatability, reproducibility, or bias associated with observed values can be calculated with a probability of 95 percent as follows: U = 2 * Ïƒ, where U is uncertainty and Ïƒ is the standard deviation from the mean I = 2.8 * Ïƒ, where I is the limit of repeatability, reproducibility, or bias." **Response: The NCHRP report is referenced in TP 76, the suggested additional information to add to TP 76 exists within the NCHRP report and is not considered essential to include in the standard. With the referencing of the NCHRP report, users interested in this level of detail can review the NCHRP for this information and other specifics. Change made in section 8.1, table reference should be table 12 not 2 and section is not 2.5 but chapter 5.**
Negative 1/52	
Rhode Island Department of Transportation (Mark E Felag) (mark.felag@dot.ri.gov) **Mr. Felag withdrew the negative in advance of the meeting.**	Page 13 - Section 2.5 - Link is incorrect. Negative can be withdrawn with a proper link or removal of it. **Response: the web address is correct – the web address is not hyperlinked within the document.** Page 15: 4.2. This sentence seems incorrect. Is there a reason to capitalize the A's? Page 15: 4.3. "General system requirement" Should requirement be pluralized? **Response: no change** Page 25 is blank, no note stating it was intentional. **Response: no change, just part of minutes submission, not related to TP 76.**

B. Technical Section letter ballot

Ballot Name:	TS 5a Reconfirmation Ballot 2015
Ballot Number	SOM_TS5a-15-01
Ballot Start Date:	1/26/2015
Ballot Due Date:	2/13/2015
All Items passed 19 affirmative, 0 negative, and 1 no vote	
Item Number	**1**
Description	Reconfirm R 31 with no changes
Item Number	**2**

Description	Reconfirm R 33 with no changes
Item Number	**3**
Description	Reconfirm R 41 with no changes
Item Number	**4**
Description	Reconfirm T282 with no changes
Georgia Department of Transportation (Peter Wu) (pwu@dot.ga.gov)	Section 8.12 refers to Section 7.6; if this is correct, it is suggested to remove certain words from the last sentence in 8.12: "If differences greater than one percent are found, the system may require maintenance or the crosstalk should be rechecked as described in Section 7.6". (7.6 does not reference cross talk). **Response: Changed the reference to 7.4 .**
Item Number	**5**
Description	Reconfirm TP 98 with no changes
Alabama Department of Transportation (Bernard (Buddy) Cox) (coxb@dot.state.al.us)	Only FHWA-PD-96-046 in the Appendixes Referenced Documents is referenced in the Appendixes. FHWA-PD-96-008 is already listed in the Standard Reference Documents and the TRB Document is not referenced anywhere. **Response: no change the description of this section states** ***The following references were <u>used</u> or referred to in the preparation of this text*:** -Second bullet of 8.2.1, second sentence, after the comma states, "at the time of the of the target vehicleâ€¦" One of the "of the" should be deleted. **Response: deleted "of the"**
Item Number	**6**
Description	Reconfirm TP 99 with no changes

C. Task Force Reports – none

V. New Business

A. AMRL/CCRL Issues –

B. Research - Submit any proposals to Curt Turgeon, MN, TS 5a Research Coordinator.

i. NCHRP update - New study, 1-57, Defining Comparable Pavement Cracking Data – project panel has rated proposals and recommended a selection, awarding is pending as of July 7. The Macrotexture RNS submitted last year by TS 5a was approved for funding by NCHRP – expect RFP in 2016.

ii. Any proposed NCHRP – International or Domestic Scans, NCHRP problem statements, NCHRP Synthesis Studies and 20-7 projects?

iii. Research Needs Statement on pavement surface texture submitted by TS 5a in 2014 was proposed for funding. Proposed RNS – Pavement Performance Data Needs - attached

C. Correspondence, calls, meetings/ Presentation by Industry – none

D. Proposed New Standards – none

E. Proposed New Task Forces – none

F. Standards Requiring Reconfirmation – see section G.

G. SOM Ballot Items (including any ASTM changes)

a. Recommend motion for concurrent ballot to extend PP 69 with the following changes: section 3.2 *inside wheelpath*—change " centered 0.875 m (34 in.)" to "centered 0.875 m (35 in.)" ; section 3.5 *outside wheelpath* – change "centered 0.875 m (34 in.)" to centered 0.875 m (35 in.).
Motion NY Second FL
Vote for: all Negative: none

b. Recommend motion for concurrent ballot to extend PP 67 with significant revisions. See appendix D
Motion KS Second AZ
Vote for: all Negative: none

c. Recommend motion for concurrent ballot to extend PP 68 and PP 70 without changes, and Technical Section ballot to reconfirm T 256 without changes.
Motion CO SecondAZ
Vote for: all Negative: none

VI. Other Items: Pooled Fund Project related to PP67, PP 68, PP 69, and PP 70: TPF-5(299) Improving the Quality of Pavement Surface Distress and Transverse Profile Data Collection and Analysis, Mergenmeier, FHWA. If interested in participating in project, contact your Research Director to submit your commitment letters – web address: http://www.pooledfund.org/Details/Study/543;

A. TPF-5(063) Improving the Quality of Pavement Profiler Measurement, Orthmeyer, FHWA update.
B. National Pavement Performance Measures discussion – general discussion of timing of research projects and MAP 21 requirements.
C. Springer, FHWA, LTPP – past 2 years using new profilers for data collection that include texture measurements. Planning to add transverse profile measurement to the systems.
D. Mid-year webinar meeting tentatively set for February 12.

VII. Adjourn – Time 3:45 pm

Appendixes

A- Agenda (no separate agenda - it is part of the minutes, so no appendix A for 2015 annual Tech Section 5a meeting minutes)
B- Attendance Roster
C- Standards
D- Ballot Items

RESEARCH PROBLEM STATEMENT

I. PROBLEM TITLE

National Pavement Performance Data Needs Assessment

II. RESEARCH PROBLEM STATEMENT

An assessment is needed to determine what types of surface distress and transverse profile data State Highway Agencies (SHA) need in order to support decision-making processes and existing as well as anticipated future reporting requirements. Examples include, but are not limited to, data to support existing SHA's pavement management systems, safety program requirements, pavement mechanistic empirical (ME) data, HPMS reporting, and future anticipated MAP-21 reporting requirements.

Tasks: The research will include the following tasks:

1. Survey and review current SHA's practices regarding currently used pavement condition standards.
2. Determination of an anticipated acceptable level of precision and bias for collected pavement performance data based upon the relative impact of distress types on decision-making processes.
3. Comparison of SHA pavement condition standards relative to AASHTO distress protocols.
4. Identification of gaps in AASHTO protocols and draft provisional standards accordingly.

Final Product:

Products include, but are not limited to: (1) a summary existing SHA data collection practices (including such things as how data are classified by type, severity, quantity, extent, units, etc.); (2) a summary of SHA desired surface distress type data; (3) identification of research needs and activities based on individual distresses; (4) how data are used in decision-making processes (implicit in this evaluation is how the data are used for modeling and pavement management purposes); (5) how collected data are used for SHA internal reporting requirements; and (6) how collected data are used for existing federal and anticipated future MAP-21 reporting requirements.

III. RESEARCH OBJECTIVE

The primary objective of this research is to better address SHA's needs from standardized pavement condition protocols.

IV. ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Estimated Budget: $250,000
Estimated Project Duration: 20 months

First Name	Last Name	Organization	Email	Phone	TS member/proxy
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Ronald	Stanevich	WV DOH	ron.l.stanevich@wv.gov	304-558-9880	
Robert	Lauzon	ConnDOT	robert.lauzon@ct.gov	860-258-0312	x
Hany	Fekry	DelDOT	hany.fekry@state.de.us	302-760-2551	
Gregory	Schieber	KS DOT	gregory.schieber@ksdot.org	785-291-3856	x
Tracy	Barnhart	AASHTO Material Reference L	tbarnhart@amrl.net	240-436-4802	
Matthew	Bluman	AASHTO (AMRL)	mbluman@amrl.net	240-436-4849	
Timothy	Ruelke	FL DOT	timothy.ruelke@dot.state.fl.us	352-955-6620	x

	A	B	C	F	G	H	I
1	**AASHTO MATERIALS TECHNICAL SECTION 5A, PAVEMENT MEASUREMENT TECHNOLOGIES Appendix C**						
2							
3	**AASHTO DESIGNATION**	**STANDARD TITLE**	**STANDARD STEWARDS**				
4							
5	M 261-96 (2009) (E 501-94 (2000))	Standard Tire for Pavement Frictional-Property Tests	TX, AL				
6	M 286-96 (2009) (E 524-88 (2000))	Smooth-Tread Standard Tire for Special-Purpose Pavement Frictional-Property Tests	TX, LA				
7	T 242-96 (2009)(E 274-97)	Frictional Properties of Paved Surfaces Using a Full-Scale Tire	NY, AL				
8	T 256-01 (2011)	Pavement Deflection Measurements	NY, AMRL				
9	T 278-90(2007)(E 303-93(2003))	Surface Frictional Properties Using the British Pendulum Tester	WV, MD				
10	T 279-96 (2010) (D 3319-90)	Accelerated Polishing of Aggregates Using the British Wheel	WV, MI				
11	T 282-01(2010) (E 556-95(2000))	Calibrating a Wheel Force or Torque Transducer Using a Calibration Platform (User Level)	MN, TX, MI				
12	T 317-04 (2009)	Prediction of Asphalt-Bound Pavement Layer Temperatures	NY, ON, FHWA (Weaver)				
13	R 20-99 (2012)	Procedures for Measuring Highway Noise	TX, FHWA (Adam Alexander)				
14	R 32-09	Calibrating the Load Cell and Deflection Sensors for a Falling Weight Deflectometer	TX, NM				
15	R 33-03 (2008)	Calibrating the Reference Load Cell Used for Reference Calibrations for Falling Weight Deflectometer	TX, TN				
16	R40-10	Measuring Pavement Profile Using a Rod and Level	MS, FHWA (Springer)				
17	R41-05 (2010)	Measuring Pavement Profile Using a Dipstick	FHWA (Springer), MS				
18	R 43M/R 43-07	Quantifying Roughness of Pavements	FL, FHWA (Orthmeyer), AL				
19	R 48-10	Determining Rut Depth in Pavements	OR, MD				
20	R 36-12	Evaluating Faulting of Concrete Pavements	WA, Ontario, FHWA (Orthmeyer)				
21	R 37-04 (2009)	Application of Ground Penetrating Radar (GPR) to Highways	FL, FHWA (Yu), TX				
22	R 55-10	Quantifying Cracks in Asphalt Pavement Surface	MD, TX, OR				
23	R 56-10	Certification of Inertial Profiling Systems	WV, FHWA (Springer), TX				
24	R 57-10	Operating Inertial Profilers and Evaluating Pavement Profiles	WV, FHWA (Springer), TX				
25	R 54-10	Pavement Ride Quality When Measured Using Inertial Profiling Systems	WA, FHWA (Swanlund), TX				
26	M 328-10	Standard Equipment Specification for Inertial Profiler	TN, FHWA (Springer)				
27	M 331-13	Smoothness of Pavement in Weigh-in-Motion (WIM) Systems	FHWA (Moravec), TX				
28	TP 76-13	Measurement of Tire/Pavement Noise Using the On-Board Sound Intensity (OBSI) Method	MN, TX				
29	PP 70-10	Collecting the Transverse Pavement Profile	AL, OR				
30	PP 69-10	Determining Pavement Deformation Parameters and Cross-Slope from Collected Transverse Profiles	AL, MS				
31	PP 68-10	Collecting Images of Pavement Surfaces for Distress Detection	MD, MS				
32	PP 67-10	Quantifying Cracks in Asphalt Pavement Surfaces from Collected Images Utilizing Automated Methods	MD, MS				
33	TP98-13	Determining the Influence of Road Surfaces on Vehicle Noise using the Statistical Isolated Pass-by (SIP) Method	FHWA (Orthmeyer), AZ				
34	TP99-13	Determining the Influence of Road Surfaces on Traffic Noise Using the Continuous-Flow Traffic Time-Integrated Method (CTIM)	FHWA (Orthmeyer), CO				

Appendix D

TS 5a

Ballot Items

Num.	Ballot Item	SOM	Concurrent	TS Ballot
1	Concurrent ballot to extend PP 67 with significant changes. Please note figure 1 in the revised PP 67: the top figure is the proposed revised figure and the bottom figure is the existing figure to be deleted. Changes are recommended by expert task group from pooled fund study TPF-5(299). See pages 10-18 of minutes		x	
2	Concurrent ballot to extend PP 69 with the following changes: section 3.2 *inside wheelpath*—change " centered 0.875 m (34 in.)" to "centered 0.875 m (35 in.)" ; section 3.5 *outside wheelpath* – change "centered 0.875 m (34 in.)" to centered 0.875 m (35 in.).		x	
3	Concurrent ballot to extend PP 68 without changes		x	
4	Concurrent ballot to extend PP 70 without changes		x	
5	Technical Section ballot to reconfirm T 256 without changes			x

Standard Practice for

Quantifying Cracks in Asphalt Pavement Surfaces from Collected Pavement Images Utilizing Automated Methods

AASHTO Designation: PP 67-14[1]

AASHTO

American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001

Standard Practice for

Quantifying Cracks in Asphalt Pavement Surfaces from Collected Pavement Images Utilizing Automated Methods

AASHTO Designation: PP 67-14[1]

AASHTO

1. SCOPE

1.1. This practice outlines the procedures for quantifying cracking distress at the network level in asphalt pavement surfaces utilizing automated methods. Detailed specifications are not included for equipment, instruments, or the associated software used to process the images. According to these specifications, any equipment that can be adequately validated to meet the functionality stipulated herein is considered acceptable. The goal is to achieve a significant level of standardization, which will contribute to the production of consistent pavement condition estimates while not unduly limiting innovation.

1.2. The automation level covered by this standard involves minimal human intervention in the process. It is understood that the current level of technology requires significant human review of the automation process to provide quality control/quality assurance (QC/QA) of the results and to detect and correct outliers. It is anticipated that the required level of human intervention will decline over the next few years.

1.3. Collect the ~~images~~pavement images to be processed according to PP 68.

1.4. Sampling of ~~images~~pavement images from the data collection standard process is acceptable before proceeding with the analysis process in this standard. The data sample is to be large enough to provide the confidence level required by the agency. Sample size and spacing will depend on construction practices and numerous other factors that impact pavement continuity. A 100 percent sample is recommended until a sampling method can be supported by statistical analysis.

1.5. *This practice does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations related to and prior to its use.*

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

- PP 68, Collecting ~~Images~~ Images of Pavement Surfaces for Distress Detection

3. TERMINOLOGY

3.1. *crack*—a fissure of the pavement material at the surface with minimum dimensions of 1-mm (0.04-in.) width and 25-mm (1-in.) length.

3.2. *crack length*— the length measured atalong the crack path using all available data points between crack termini along the crack path.the length is measured between crack termini. If a terminus was created due to reaching the maximum length, a new crack begins at the terminus.

3.3. *crack orientation*—the angular measurement in degrees between the direction of travel and a line drawn between the ends of the crack termini as measured within the measurement zone of interest.

3.4. *crack position*—the coordinates of the midpoint of the crack measured perpendicular to the shoulder edge of the pavement and the longitudinal location relative to the starting collection point.

3.5. *crack terminus*—the point at which the crack width goes below and remains less than 1 mm (0.04 in.) for a 10-mm (0.4-in.) length, or the intersection with another crack, or when the maximum of 3.67 m (12 ft), is reached or the end of a summary section is reached.

3.6. *crack width*—the average gap in millimeters (inches) between the two edges of a crack measured at points along the gapcrack with a minimum spacing ofbetween 31 mm (0.1204 in.) and 10 mm (0.4 in.).

3.7. *extent of cracking*—the sum of the lengths in meters (feet) of all cracks in the summary section for eachand zone where appropriatewithin the section.

3.7. Note 1 - For pattern cracking, agencies have the option to report extent by area as the sum of the areas in square meters (feet) of all pattern areas for each zone within the summary section.

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3.8. *inside wheelpath*—a longitudinal strip of pavement 1.0 m (39 in.) wide and centered 0.875 m (34 in.) to the left of the centerline of the lane in the direction of travel.

3.9. *lane*—the traveled surface between the inside edge of the pavement markings. In the absence of markings, an equivalent portion of the pavement surface.

Note 2 - Where cracks (or the paved surface edge) exist beyond the pavement markings, but within 0.3 m (1 ft) of the pavement markings, agencies have the option to move the lane edges so that the lateral extent of the lane is increased to include the new boundary.

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3.8.

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3.9.3.10. *longitudinal crack*—a crack at least 0.3 m (12 in.) long and with a crack orientation between and including +120 and –120 degrees of relative to the lane centerline.

3.11. *measurement zone*—one of the five strips of pavement created by the wheelpaths and the areas between and outside the wheelpaths.

3.10.3.12. *other crack* - all cracks not identified as longitudinal, pattern, or transverse.

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3.11.3.13. *outside wheelpath*—a longitudinal strip of pavement 1.0 m (39 in.) wide and centered 0.875 m (34 in.) to the right of the centerline of the lane in the direction of travel.

3.12. *outside lane edge*—a line 100 mm (4 in.) beyond the outside limit of the edge pavement marking. In the absence of an edge pavement marking, it is a user-defined distance from the left edge marking or pavement centerline.

3.14. *pattern crack*—a crack that is part of a network of cracks that form an identifiable area or grouping of cracks. shapes. For this practice, this includes all cracks that are not defined as transverse or longitudinal.

3.13. Note 3 - An identifiable area or grouping of cracks may be determined by interconnecting cracks with a length of less than 0.3 m (12 in.) or through a process designed to separate independent cracks from cracks that due to their proximity are likely related. The process could be based on machine learning or other artificial intelligence techniques. One method currently being evaluated establishes (150 mm) buffers around each crack and computes how much of the buffer area is shared with the buffer areas for other cracks. A crack sharing less than a threshold of its area (50%) with other cracks is considered independent and not part of a pattern.

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3.15. *pavement image*— a representation of the pavement that describes a characteristic (gray scale, color, temperature, elevation, etc.) of a matrix of points (pixels) on the pavement surface.

3.14.3.16. *severity of cracking*—the average width in millimeters (inches) of all cracks in the summary section for each and zone where appropriate within the section.

3.15.3.17. *summary section*—a portion of a pavement lane over which the data are summarized.

3.18. *transverse crack*—a crack at least 0.3 m (12 in.) long and with a crack orientation between and including 870 and 1010 degrees tofrelative to the lane centerline.

3.16.

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4. SIGNIFICANCE AND USE

4.1. This practice outlines the procedures for quantifying cracking distress at the network level in asphalt pavement surfaces utilizing automated methods.

4.2. The level of development of the current technology requires that the collection and analysis processes be linked together. It is hoped that in the future, a standard set of imagespavement images may be created by the collection equipment from a standard pavement distress simulation package yet to be developed and used to evaluate and control the performance of this method.

5. DATA COLLECTION

5.1. Data are collected according to PP 68.

6. DATA REDUCTION—CRACK DETECTION

6.1. The system that detects the presence of a pavement anomaly that is commonly considered a crack typically involves one or more image analysis software routines.

6.2. It is anticipated that future detection processes may involve the analysis of imagespavement images of multiple characteristics to improve the reliability of the detection process. As of this revision, elevation processes are becoming available.

6.3. The detection process is clearly dependent on the quality of the imagespavement images to be analyzed. Currently, there is no reliable method to independently measure the performance of the collection and analysis processes. The criteria listed herein therefore represent the requirements of the total collection and analysis system. It is anticipated that a reliable method will be developed to independently establish the image quality so that, in the future, each process can be evaluated separately. Until then, a validation process is described in Section 109.

6.4. *An acceptable result of this process is a crack map in which at least*:

6.4.1. Thirty-three percent of the cracks less than 3 mm (0.12 in.) and 60 percent of cracks from 3 mm (0.12 in.) to less than 5 mm (0.2 in.) wide are mapped (see Note 41).

6.4.2. Eighty-five percent of the cracks 5 mm (0.2 in.) or wider are mapped (see Note 14).

6.4.3. A crack is considered mapped if at least 85 percent of its length is detected (see Note 41).

6.4.4. The imagespavement images should be sufficiently void of erroneous differences between data point values such that a section of pavement without distress, discontinuities, or pavement markings contains less than 3 m (10 ft) total length of detected false cracking in 50 m^2 (540 ft^2) of pavement (see Note 41). The determination of this capability will be made utilizing a minimum of ten 0.03-km (100-ft) samples of various pavement types that meet the criteria.

Note 014—These performance values are the estimates of a panel of experts based on current technology. Ongoing research and equipment developments will better define and improve these values over the next few years. As capabilities are better defined, separate levels of performance may be established for two or three classes of equipment and software.

7. DATA ANALYSIS—-CRACK CLASSIFICATION AND VALUATION

7.1. The summary section distance for cracking data is recommended to be- 0.01533 km (100 ft0.01 mi) or less to more clearly identify extent.

7.2. Detected pattern cracks and longitudinal cracks (not transverse) are separated into five measurement zones across the pavement.

7.2.1. Zone 1 is between the inside wheelpath and the lane edge at the adjacent lane.

7.2.2. Zone 2 is the inside wheelpath.

7.2.3. Zone 3 is the space between the wheelpaths.

7.2.4. Zone 4 is the outside wheelpath.

7.2.5. Zone 5 is between the outside wheelpath and the outside lane edge.

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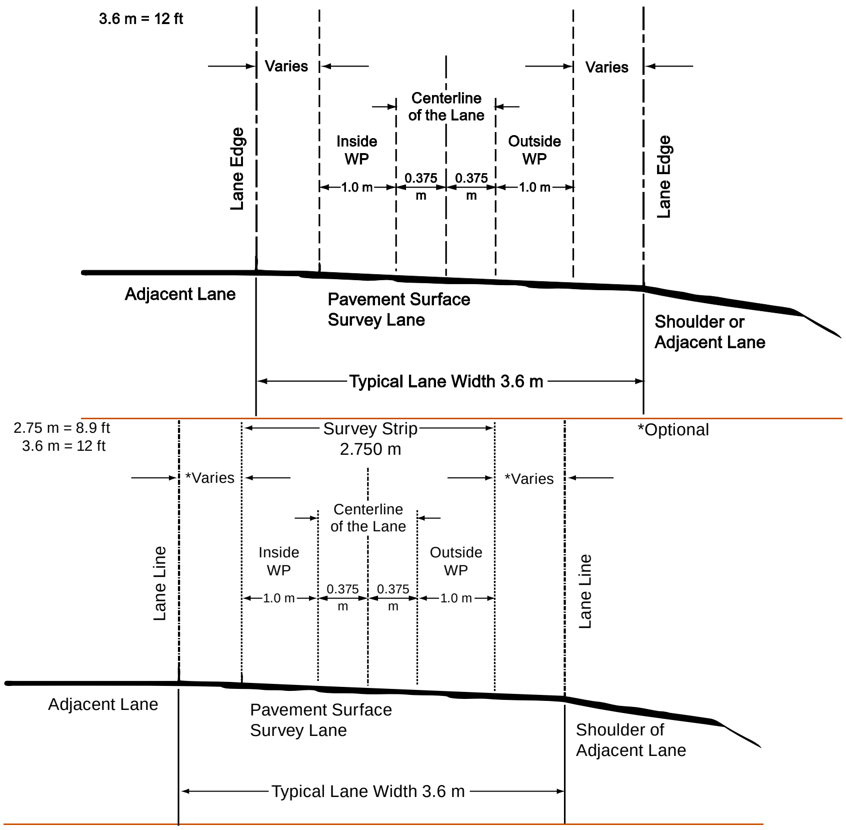

~~7.2.5.~~ **Figure 1**—Cross Section of Survey Lane Showing Wheelpaths and Defined Survey Area between Wheelpaths

7.3. *Pattern cracks will be summarized by*:

7.3.1. The sum of the lengths in meters (feet) of all pattern cracks in the summary section shall be the extent of pattern cracking for each zone within the summary section. (Additionally, an extent by area can be reported as defined in Note 1 of Section 3.7)

7.3.2. The average width in millimeters (inches) of all pattern cracks in the summary section for a given zone shall be the severity of the pattern cracking for that ~~each~~ zone within the summary section.

7.4. *Longitudinal cracks will be summarized by*:

7.4.1. The sum of the lengths in meters (feet) of all longitudinal cracks in the summary section shall be the extent of longitudinal cracking for each zone within the summary section.

7.4.2. The average width in millimeters (inches) of all longitudinal cracks within the summary section for a given zone shall be the severity of longitudinal cracking for ~~each~~ that zone within the summary section.

7.5. *Other cracks will be summarized by*:

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7.5.1. The sum of the lengths in meters (feet) of all other cracks in the summary section shall be the extent of other cracking for each zone within the summary section.

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7.5.2. The average width in millimeters (inches) of all other cracks within the summary section for a given zone shall be the severity of other cracking for that zone within the summary section.

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~~7.5.~~7.6. *Transverse cracks will be summarized by*:

~~7.5.1.~~7.6.1. The sum of the lengths in meters (feet) of all the transverse cracks in the summary section shall be the extent of transverse cracking ~~in each zone~~ within the summary section.

~~7.5.2.~~7.6.2. The average width in millimeters (inches) of all transverse cracks within the summary section shall be the severity of transverse cracking ~~in each zone~~ within the summary section.

~~7.6.~~ **Note ~~2~~5** ~~—Note 2 —~~Cracks detected from intensity ~~images~~ images alone and that are greater than 25 mm (1 in.) wide may reflect that a narrower crack is present and was sealed. Intensity ~~images~~ images alone cannot separate these conditions. If this is the only technology employed, it is recommended that the system flag these occurrences for technician analysis. This analysis can be supported by input from the data collection operator by flagging when crack sealing is present. The advent of elevation ~~images~~ images that can be analyzed along with intensity ~~images~~ images should resolve this issue.

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8. DATA REPORTING

8.1. The calculated extent of longitudinal cracks, pattern ~~each~~ cracks, and other cracks ~~category (Zones 1–5 pattern, Zones 1–5 longitudinal, and transverse) in meters (feet)~~ shall be ~~the~~ reported by measurement zone ~~extent value~~ for each crack category. The calculated extent of transverse cracks shall be reported as a single value for the entire summary section.

8.2. The calculated severity of longitudinal cracks, pattern cracks, and other cracks ~~each category~~ in each measurement zone ~~in millimeters (inches)~~ shall be the reported severity ~~value~~ for that crack category. The calculated severity of transverse cracks shall be reported as a single value for the entire summary section.

Note ~~2~~6—Therefore, each summary section will have ~~22~~32 values that characterize the cracking contained therein if both extent and severity are deemed necessary.

~~8.3. Each of these values may be first normalized to a scale of 0 to 10 with 10 being the most severe. Those with a value equal to or exceeding the average value of the worst (highest extent and severity values) 10 percent of the historical, agency-wide data set for the past 10 years would be assigned a 10 and the remainder values linearly transferred to the normalized scale. The normalized values may then be combined in various ways to provide a reduced data set for reporting (a) more general cracking index(es) for each section at the agency's discretion.~~

~~**Note 3**—In this proposed normalization method, the resulting normalized values would get more sensitive to the amount of distress as the worst 10 percent of the pavements have improved values. An effective distribution is thus maintained over the entire scale but at the expense of sacrificing absolute comparison capability. Since a 10-year average is used and system changes tend to be very slow, the shifting effect will be extremely slow and thus should not affect short-term comparisons. Also, since each system will be normalizing to itself, any attempted comparison~~

between systems would be erroneous. Also , as national data sets are established, a nationally based normalization can be developed that would allow for more widespread comparison.

9. DATA INTERPRETATION

9.1. The agency is free to utilize the reported data as best fits its pavement management needs.

9.2. Any increase in the extent and severity of cracking in Zones 2 and 4 above that in Zone 3 is expected to typically reflect the impact of traffic loading.

9.3. Agencies are alerted that dividing the scalar extent and severity values into level categories or bins can result in erratic results. When values are near the bin limits, natural variation in the data will cause dramatic shifts in results. Such converting can be useful, however, for general comparison to previously collected data in which bin limits were used.

10. SYSTEM VALIDATION

10.1. The process of calibrating and checking the performance of the crack detection and analysis process is left to the agency. Generally, the agency should follow the manufacturer's recommendations for calibrating and verifying the performance of the process. The following considerations should be included in any program.

10.2. The interrelationship between the supplied imagespavement images and the performance of the processing system is evident.

10.3. A standard set of imagespavement images from the collection equipment should be created that challenge the analysis processes with the full range of crack types, extents, and severity. The ground truth for these imagespavement images is to be determined by manually surveying 100 percent of the pavement sections themselves (not their imagespavement images). Manual examination of the imagespavement images should be used only as a diagnostic if unsatisfactory results are obtained. These standard imagespavement images can be used repeatedly until the collection process is modified, necessitating the collection of a new set.

10.4. The standard imagespavement images created according to Section 910.3 should be used to verify performance of the detection and analysis processes on a routine basis. The frequency depends on the system's past performance and the risk associated with having to reprocess all data since the last check, should a failure occur.

10.5. Generally, performance can be divided into two sections: the ability to create an acceptable crack map and the ability to properly analyze the created map.

10.6. The ability to create an acceptable map is considered the most challenging and therefore should be checked most frequently. The results of the analysis portion should correlate better than 95 percent .with trained observers reviewing the imagespavement images

11. VALIDATION/ACCEPTANCE REPORT

11.1. The detection performance report should present, in tabular form, the ground truth values and the values that the automated detection process derived for each severity category listed in Section 65.4 with the percent of success. It should also report the length of false cracks detected per each 50 m^2 (540 ft^2) of pavement.

11.2. The analysis performance report should compare the values in each crack reporting category with the values derived by trained observers utilizing the crack map generated by the automated detection process. The test sections should be the same ones used for the verification of the analysis process.

12. CHECKING THE PERFORMANCE

12.1. A recommended check of the performance of the entire crack collection, detection, and analysis process is to routinely process the data from one or more validation sites. The validation sites should represent most of the data collection variables that the system is expected to encounter during routine data collection. Results are then compared for reasonableness with previous runs. Each agency should set their own frequency and degree of analysis based on their experiences. A typical implementation of this process would involve 5 km (3 miles) of collected data and be performed monthly, as an example.

13. KEYWORDS

13.1. Asphalt pavement surface; automated data collection; pavement cracking distress; pavement images; pavement management.

14. REFERENCES

14.1. ASTM E 1656/E 1656M, Standard Guide for Classification of Automated Pavement Condition Survey Equipment.

14.2. *Distress Identification Manual for the Long-Term Pavement Performance Program*, FHWA Report RD-03-031.

[1] First published as an AASHTO Provisional Standard in 2010.

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