Evaluation of Strategic Highway Research Program–Long-Term Pavement Performance Surface Distress Data Collection Procedures

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Surface distress is commonly perceived to be one of the primary indicators of pavement performance. As such, the collection of these data for the Long-Term Pavement Performance (LTPP) program is a significant aspect of this overall effort—so significant in fact that there have been substantial efforts to develop a distress identification manual and guidelines for the measurement and recording of these distresses. Elaborate accreditation procedures also have been implemented to provide for the most uniform and consistent data possible. To further ensure that adequate observations of these data are obtained, two methods of data collection were utilized. The primary method of distress data collection for the LTPP program is from the digital analysis of 35-mm film taken of each test section on a routine basis. As a backup, manual surveys were conducted, as needed. From studies of the distress data collected to date, several observations were made. The first, and probably most significant, observation was that relatively few of these test sections have much distress. Second, some types of the distress occur more commonly than others. A variety of potential reasons for the limited occurrence of these distresses are considered in detail. The third observation is that there are distinct differences in the distress data collected from these two methods of distress data collection. Possible reasons for why these differences exist are discussed in detail. It is important to recognize these differences to ensure that the data are not misinterpreted. These limitations and distinctions are not intended to imply superiority of one methodology over the other. Instead, the studies should serve to document where additional research may be warranted to improve both methodologies. These studies also highlight the importance of not relying too heavily on either method of distress data collection alone.

Considerable quantities of surface distress data have been collected as part of the Long-Term Pavement Performance (LTPP) studies. Both manual and semiautomated procedures were utilized for the collection of these data. The objectives of this paper are twofold. The first objective is to review and summarize the distress data collected for the LTPP studies to date. The second objective is to compare and evaluate the differences between these two methods for collecting surface distress data on the basis of available data. This paper is not intended to prove that one method of distress data collection is superior to the other, but rather to highlight the differences and limitations of each to aid in the use and development of these data collection procedures in the future.

These studies were limited to distress data from the southern LTPP region, incorporating 261 general pavement study (GPS) test sections from New Mexico, Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Tennessee, South Carolina, Alabama, Georgia, Florida, and the Commonwealth of Puerto Rico. These are standard sections of in-service highway. Of the 261 sections, 172 are asphalt concrete pavement (ACP), 52 are jointed concrete pavement (JCP), and 37 are continuously reinforced concrete pavement (CRCP).

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Since the initiation of the LTPP studies in 1988, several rounds of both manual and semiautomated distress data have been collected in the southern region. Although limiting this study to the southern region introduces some biases in the types of distress observed, there is a sufficient distribution of the various pavement types and sufficient volumes of distress surveys to be reasonably representative of most distress manifestations. This study incorporates 586 surveys of ACP, 172 of JCP, and 122 of CRCP. These surveys represent multiple rounds of distress data collected at each of the test sections noted earlier.

To highlight the types of distress data being collected as part of the LTPP studies, a brief background will be provided on the guidelines for the collection of these distress data. Considerable effort has been made over the years to develop standard guidelines for collecting distress data. These guidelines serve an essential role in helping to provide greater consistency and uniformity to the observations made and the distress recorded.

DISTRESS IDENTIFICATION MANUAL

The guidelines for distress identification for the LTPP studies were first published in 1989 (*1*). These guidelines have gone through several iterations since that time, culminating with the most recent distress identification manual published in May 1993 (*2*). The LTPP Distress Identification Manual incorporates many of the guidelines provided in previous manuals of this type (*3–5*). Revisions to the manual are a direct reflection of areas identified in which inconsistencies in interpretation have resulted in problems in obtaining uniform and consistent distress data. The distress data types collected and their units of measurement are summarized in Tables 1 through 3 for ACP, JCP, and CRCP, respectively.

DATA COLLECTION PROCEDURES

The predominant methodology employed is classified as semiautomated distress data collection. The test sections were filmed by the PASCO Road Recon Unit. The camera was mounted on a boom in front of a vehicle so that it could photograph one full lane of pavement at a time while minimizing any potential dis-

TABLE 1 Asphalt Concrete-Surfaced Pavement Distress Types

DISTRESS TYPE	UNIT OF MEASURE	DEFINED SEVERITY LEVELS?
Cracking		
1. Fatigue Cracking	Square Meters	Yes
2. Block Cracking	Square Meters	Yes
3. Edge Cracking	Meters	Yes
4a. Wheel Path Longitudinal Cracking	Meters	Yes
4b. Non-Wheel Path Longitudinal Cracking	Meters	Yes
5. Reflection Cracking at Joints		
Transverse Reflection Cracking	Number, Meters	Yes
Longitudinal Reflection Cracking	Meters	Yes
6. Transverse Cracking	Number, Meters	Yes
Patching and Potholes		
7. Patch/Patch Deterioration	Number, Square Meters	Yes
8. Potholes	Number, Square Meters	Yes
Surface Deformation		
9. Rutting	Millimeters	No
10. Shoving	Number, Square Meters	No
Surface Defects		
11. Bleeding	Square Meters	Yes
12. Polished Aggregate	Square Meters	No
13. Raveling	Square Meters	Yes
Miscellaneous Distresses		
14. Lane-to-Shoulder Dropoff	Millimeters	No
15. Water Bleeding and Pumping	Number, Meters	No

TABLE 2 Jointed Concrete-Surfaced Pavement Distress Types

DISTRESS TYPE	UNIT OF MEASURE	DEFINED SEVERITY LEVELS?
Cracking		
1. Corner Breaks	Number	Yes
2. Durability Cracking ("D" Cracking)	Number of Slabs, Square Meters	Yes
3. Longitudinal Cracking	Meters	Yes
4. Transverse Cracking	Number, Meters	Yes
Joint Deficiencies		
5a. Transverse Joint Seal Damage	Number	Yes
5b. Longitudinal Joint Seal Damage	Number, Meters	No
6. Spalling of Longitudinal Joints	Meters	Yes
7. Spalling of Transverse Joints	Number, Meters	Yes
Surface Defects		
8a. Map Cracking	Number, Square Meters	No
8b. Scaling	Number, Square Meters	No
9. Polished Aggregate	Square Meters	No
10. Popouts	Number/Square Meter	No
Miscellaneous Distress		
11. Blowups	Number	No
12. Faulting of Transverse Joints and Cracks	Millimeters	No
13. Lane-to-Shoulder Dropoff	Millimeters	No
14. Lane-to-Shoulder Separation	Millimeters	No
15. Patch/Patch Deterioration	Number, Square Meters	Yes
16. Water Bleeding and Pumping	Number, Meters	No

TABLE 3 CRCP-Surfaced Distress Types

DISTRESS TYPE	UNIT OF MEASURE	DEFINED SEVERITY LEVELS?
Cracking		
1. Durability Cracking ("D" Cracking)	Number, Square Meters	Yes
2. Longitudinal Cracking	Meters	Yes
3. Transverse Cracking	Number, Meters	Yes
Surface Defects		
4a. Map Cracking	Number, Square Meters	No
4b. Scaling	Number, Square Meters	No
5. Polished Aggregate	Square Meters	No
6. Popouts	Number/Square Meters	No
Miscellaneous Distress		
7. Blowups	Number	No
8. Transverse Construction Joint Deterioration	Number	Yes
9. Lane-to-Shoulder Dropoff	Millimeters	No
10. Lane-to-Shoulder Separation	Millimeters	No
11. Patch/Patch Deterioration	Number, Square Meters	Yes
12. Punchouts	Number	Yes
13. Spalling of Longitudinal Joints	Meters	Yes
14. Water Bleeding and Pumping	Number, Meters	No
15. Longitudinal Joint Seal Damage	Number, Meters	No

tortion. Filming was conducted at night to control the lighting and potential for unwanted shadows. After the film was developed, it was then digitally analyzed by a technician to extract the distress data quantities. The film and distress quantities noted were then reviewed by the regional coordination offices as a quality control check. Discrepancies in the interpretation of the film were noted and edited as necessary.

This filming process provides several advantages. It allows the section to be reevaluated at any time should distress definitions change. Similarly, the film allows for the use of better technology for digital analysis as it becomes available. The filming process also minimizes the safety hazards of collecting distress data in the field.

As a backup to the filming procedure, personnel within the LTPP regional coordination offices were trained to collect these distress data through visual inspection, should the PASCO unit be unavailable. An accreditation program has been initiated (*6*) to provide greater consistency among the surveyors in the interpretation of the distress identification manual. Manual surveys allow for considerably greater freedom in reviewing a test section for the presence of distress.

DATA AVAILABILITY

The presence of distress data has numerous implications. To some analysts, this is an indication of which distresses are most or least common, or both. To others this information might reflect a bias in the types of sections being monitored, and perhaps an indication of adjustments or additional sections that need to be sought to represent equally all distress manifestations. A third possibility is that the magnitudes of data available for each distress type to some extent could indicate which distress manifestations are most readily identifiable by LTPP distress identification procedures and perhaps highlight those distress manifestations for which better identification techniques are still warranted.

As one might expect, some of the distresses listed in Tables 1 through 3 are considerably more common than others. Some distresses, although known to be common, can be fairly difficult to discern. Distress manifestations, such as water bleeding and pumping, can be dependent on the timing of the distress survey. If the distress survey is conducted shortly after a heavy rain, pumping may be easily detected. If the timing is wrong, however, these types of distresses will likely go undocumented. Another good example of these timing-related distresses is a blowup in the concrete pavements. Several sections have been reported as having blowups. However, such a phenomenon is usually so catastrophic that it is typically patched immediately. By the time a distress survey is conducted at these locations, the surveyor can record only the location of the patch. Potholes typically fall into this same category.

Still other distress manifestations are uncommon by definition. One example would be edge cracking, which is defined to occur where paved shoulders do not exist. This type of distress is common in states where paved shoulders are not used; however, there are few states (at least in the southern region) where paved shoulders are not common practice. Similarly, reflective cracking over joints by definition is obviously limited to the asphalt overlays of concrete pavement. With these studies being limited to the test sections in the southern region, some of these distresses simply are not common to this area of the country (e.g., D-cracking in the concrete test sections).

For the 261 GPS test sections established in the southern region, several rounds of both manual and semiautomated distress data collection have been conducted, as previously noted. The results of these surveys have been tabulated and summarized to indicate the frequency of occurrence of each of the distress types on the applicable pavement types. These results are provided in Tables 4 through 6 for ACP, JCP, and CRCP, respectively. These results reflect the types of distresses recorded at these test sections over the past 5 years. The tables also have been highlighted to note those distresses considered timing dependent, uncommon by definition, and those uncommon to the Southeast, as noted earlier. The distresses indicated to be not available are primarily those requiring measurement of differences in vertical profile, which in most cases is being accommodated differently in the two methodologies. These distinctions will be discussed further under the heading of limitations.

Few of these results are particularly surprising. Some of these distresses for various reasons are not expected to be commonly noted. These tables have been further highlighted to distinguish those distress types that were actually noted on greater than 20 percent of the section. Those not highlighted are the distress types that are inexplicably minimal. One can only speculate whether these distresses will become more common with time or whether they are closely related to materials or construction deficiencies that may have been filtered out in the site nomination and selection process. Regardless of how such voids in the distress data occur, no meaningful analysis can be conducted for distresses of this type until they become more common.

LIMITATIONS OF DISTRESS DATA COLLECTION PROCEDURES

The authors are not aware of any foolproof method for the collection of distress data. All procedures currently in use have their

TABLE 4 Observations of ACP Distress

DISTRESS	L	%	M	%	H	%	TOT	%
CRACKING								
FATIGUE	118	20	48	8	10	2	133	23
BLOCK	16	3	8	1	0	0	19	3
EDGE	17	3	3	1	3	1	19	3
LONGITUDINAL	293	50	58	10	3	1	295	50
REFLECTIVE, LONG.	7	1	2	0	2	0	7	1
REFLECTIVE, TRAN.	10	2	4	1	3	1	10	2
TRANSVERSE	286	49	97	17	20	3	283	48
PATCHING AND POTHOLES								
PATCH DETERIORATION	41	7	15	3	7	1	49	8
POTHOLES	9	2	2	0	2	0	10	2
SURFACE DEFORMATION								
RUTTING	--	--	--	--	--	--	N/A	N/A
SHOVING	--	--	--	--	--	--	1	0
SURFACE DEFECTS								
BLEEDING	53	9	7	1	1	0	57	10
POLISHED AGGREGATE	--	--	--	--	--	--	0	0
RAVELING & WEATHERING	32	5	7	1	3	1	30	5
MISCELLANEOUS DISTRESSES								
LANE TO SHOULDER DROPOFF	--	--	--	--	--	--	N/A	N/A
WATER BLEEDING & PUMPING	--	--	--	--	--	--	15	3

TIMING DEPENDENT
UNCOMMON BY DEFINITION
NOT COMMON IN SOUTHEAST
COMMON DISTRESS

N/A - Not Available
-- - No Severity Levels
[1] Observations noted are number of surveys (either manual or PASCO) for which the given distress was noted at the specified severity level.

TABLE 5 Observations of JCP Distress

DISTRESS	L	%	M	%	H	%	TOT	%
CRACKING								
CORNER BREAKS	13	8	6	3	4	2	20	12
DURABILITY "D"	0	0	0	0	0	0	0	0
LONGITUDINAL	18	10	0	0	0	0	18	10
TRANSVERSE	30	17	27	16	12	7	39	23
JOINT DEFICIENCIES								
JOINT SEAL DAMAGE	51	30	26	15	29	17	63	37
SPALLING OF LONG. JOINTS	25	15	9	5	0	0	24	14
SPALLING OF TRANS. JOINTS	77	45	11	6	7	4	85	49
SURFACE DEFECTS								
MAP CRACKING AND SCALING	--	--	--	--	--	--	11	6
POLISHED AGGREGATE	--	--	--	--	--	--	3	2
POP OUTS	--	--	--	--	--	--	17	10
MISCELLANEOUS DISTRESS								
BLOW UPS	--	--	--	--	--	--	0	0
FAULTING OF TRANS JTS &CRKS	--	--	--	--	--	--	N/A	N/A
LANE TO SHOULDER DROPOFF	--	--	--	--	--	--	N/A	N/A
LANE TO SHOULDER SEPARATION	--	--	--	--	--	--	16	9
AC PATCH DETERIORATION	7	4	7	4	1	1	12	7
PCC PATCH DETERIORATION	2	1	0	0	1	1	3	2
WATER BLEEDING & PUMPING	--	--	--	--	--	--	5	0

TIMING DEPENDENT
UNCOMMON BY DEFINITION
NOT COMMON IN SOUTHEAST
COMMON DISTRESS

N/A - Not Available
-- - No Severity Levels
Observations noted are number of surveys (either manual or PASCO) for which the given distress was noted at the specified severity level.

TABLE 6 Observations of CRCP Distress

DISTRESS	L	%	M	%	H	%	TOT	%
CRACKING								
DURABILITY "D"	0	0	0	0	0	0	0	0
LONGITUDINAL	9	7	2	2	0	0	9	7
TRANSVERSE	118	97	56	46	5	4	118	97
SURFACE DEFECTS								
'MAP CRACKING AND SCALING	--	--	--	--	--	--	6	5
POLISHED AGGREGATE	--	--	--	--	--	--	0	0
POP OUTS	--	--	--	--	--	--	11	13
MISCELLANEOUS DISTRESSES								
BLOW UPS	--	--	--	--	--	--	1	1
CONSTRUCTION JOINT DAMAGE	9	7	1	1	0	0	9	7
LANE TO SHOULDER DROPOFF	--	--	--	--	--	--	N/A	N/A
LANE TO SHOULDER SEPARATION	--	--	--	--	--	--	21	17
AC PATCH DETERIORATION	3	2	0	0	2	2	5	4
PCC PATCH DETERIORATION	3	2	0	0	0	0	3	2
PUNCHOUTS	5	4	0	0	1	1	6	5
SPALLING OF LONG. JOINTS	25	20	2	2	0	0	24	20
WATER BLEEDING & PUMPING	--	--	--	--	--	--	1	1
LONG. JOINT SEAL DAMAGE	--	--	--	--	--	--	N/A	N/A

TIMING DEPENDENT
UNCOMMON BY DEFINITION
NOT COMMON IN SOUTHEAST
COMMON DISTRESS

N/A - Not Available
-- - No Severity Levels
Observations noted are number of surveys (either manual or PASCO) for which the given distress was noted at the specified severity level.

own limitations. As the limitations of the procedures utilized for the LTPP studies are reviewed, it should be emphasized again that the objective here is not to minimize the value of these data (or the methods used to collect them) in any way. Rather, it is hoped that through the review of these limitations ideas for further refinement and development of these procedures might be spawned. In the meantime, users of these data can become more familiar with how to generate and make better use of these data.

Both data collection procedures utilize the same distress identification manual and ideally should generate the same distress data summary statistics for a given section at a given time. First one must recognize, however, that these sections are seldom surveyed by both procedures at the same time. Although this tends to make direct comparisons of the two methodologies difficult, it is not unreasonable to expect similar trends in the distress data for a given section: that is, if one methodology showed block cracking in 1991 and 1993, one might also expect the other methodology to also display block cracking in 1992. It also appears reasonable to expect the same relative order of magnitude for the quantities of distress noted (say within 25 percent). However, limitations make both procedures less than ideal. In the following paragraphs, the limitations of each methodology will be discussed to help explain some of the differences between the two methodologies and identify efforts that have been initiated to minimize these limitations. It is anticipated that as the limitations of each methodology are remedied, the results of the two methodologies will begin to provide more comparable results.

Reduction of Film

The three primary limitations of the semiautomated procedure are as follows:

1. Dependency on film resolution. With the distress quantities coming strictly from what is visible on the film, obviously the film resolution is fairly critical. Although improvements are being made in this area, the data available thus far still clearly indicate that the low severity levels for some distress types are simply not visible on the film. Distresses such as fatigue cracking in ACP and transverse cracking in CRCP are common examples of distresses that require higher film resolution.
2. Lack of depth perception. Distresses that require any depth perception or measurements of differences in surface elevations present problems during film reduction. Distress types such as faulting or lane-to-shoulder dropoff are virtually impossible to identify from the film. In some instances, establishing severity levels is also dependent on depth perception. Depths of potholes, settlement of corner breaks in JCP, or punchouts in CRCP are all dependent on depth perception.
3. Film contrast. Identification of some distress types where contrast is critical, such as joint seal damage in JCP, or surface distresses such as polished aggregate, bleeding or raveling and weathering, can prove difficult if not impossible.

Manual Distress Surveys

Two of the primary limitations of the manual distress surveys are as follows:

1. Potential for human error. Although it exists in both methodologies, the potential for human error is considerably more prevalent with manual distress surveys. One can tire of reviewing film but there are many means of remedying boredom. In the field, both physical and mental fatigue can hamper one's judgment, but taking a break is not always possible once traffic control has been established and traffic is backing up. Environmental conditions, such as excessive heat or cold or impending bad weather or personal safety from passing traffic, all serve to distract a surveyor in the field. Even the most experienced surveyors cannot help but be affected to some extent by the environment in which they are working. When vehicles weighing more than 80,000 lb rush by at speeds higher than 60 or 70 mph, a surveyor better take notice. Of course inadequately trained surveyors can also lead to other types of human error. This has not proven to be a significant concern thus far, however, with the training provided.
2. Discrepancies in distress identification associated with lighting. Unlike the filming process, where filming is conducted at night and lighting of the pavement surface is controlled, the manual surveyor must adjust to the lighting conditions for each site. If the surveyor is not positioned correctly to account for the position of the sun in the sky, low severity distresses can be completely overlooked.

Although there are other less significant deficiencies associated with each methodology, these limitations represent most of the distinctions between these methodologies and prevent directly interchangeable survey results. Recognizing the types of distress data being collected, how they are being collected, and the limitations associated with these procedures, one can now proceed with the comparisons of the survey results.

COMPARISON OF DATA FROM THE TWO METHODOLOGIES

After the availability of the various distress data elements for each of the three pavement types and the limitations associated with the two methodologies have been reviewed, the data may be studied to establish how the data from these two methodologies compare. To conduct comparisons of the distress data collected to date, all of the distress surveys were paired off (grouping one semiautomated distress survey with one manual distress survey for the same test section and comparable date). The surveys were sorted under the headings of manual and film. Averages of the quantities of distress for each distress type at each severity level were tabulated and have been summarized in Tables 7 through 9 for ACP, JCP, and CRCP, respectively. Standard *t*-tests were conducted on these data to establish where "significant" differences existed. Distress types exhibiting significant differences have been highlighted in these tables for discussion purposes.

As can be seen from these tables, for many if not all of the cracking distresses, low severity levels typically were significantly lower from the film than from the manual distress surveys. In some instances, this occurred even for the medium-severity distresses. Interestingly, however, the film reduction appears to overcompensate by noting slightly greater quantities of high-severity distress than those observed in the field. The most notable exception is the transverse cracking of ACP, where the trend is just the opposite. A logical explanation for this trend reversal for transverse cracking of ACP has not been identified.

TABLE 7 Comparisons for ACP

DISTRESS	UNITS	LOW M	LOW F	MED M	MED F	HIGH M	HIGH F	TOTAL M	TOTAL F
CRACKING									
FATIGUE	SQUARE METER	15.9	8.0	8.3	0.9	0.6	0.0	24.9	9.6
BLOCK	SQUARE METER	13.2	6.6	3.5	1.3	0.0	0.0	16.7	8.0
EDGE	METERS	4.2	0.4	0.0	0.0	0.0	0.0	4.2	0.4
LONGITUDINAL	METERS	34.4	32.4	1.7	1.5	0.2	0.0	36.3	33.9
REFLECTIVE, LONG.	METERS	1.1	0.7	0.0	0.0	0.0	0.0	1.2	0.7
REFLECTIVE, TRAN.	METERS	0.1	0.7	0.0	0.1	0.0	0.2	0.2	1.0
TRANSVERSE	METERS	12.8	17.2	2.5	2.3	0.5	0.2	15.7	19.6
PATCHING AND POTHOLES									
PATCH DETERIORATION	SQUARE METER	2.3	0.5	0.1	0.2	0.0	0.0	2.5	0.7
POTHOLES	SQUARE METER	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0
SURFACE DEFORMATION									
RUTTING	MILLIMETERS	--	--	--	--	--	--	N/A	N/A
SHOVING	SQUARE METER	--	--	--	--	--	--	0.2	0.0
SURFACE DEFECTS									
BLEEDING	SQUARE METER	30.0	3.1	7.5	2.4	0.0	0.0	37.5	5.4
POLISHED AGGREGATE	SQUARE METER	--	--	--	--	--	--	0.0	0.0
RAVELING & WEATHERING	SQUARE METER	10.5	0.5	3.0	0.0	0.0	0.0	13.2	0.5
MISCELLANEOUS DISTRESSES									
LANE TO SHOULDER DROPOFF	MILLIMETERS	--	--	--	--	--	--	N/A	N/A
WATER BLEEDING & PUMPING	METERS	--	--	--	--	--	--	0.7	0.0

SIGNIFICANTLY DIFFERENT
M : MANUAL
F : FILM

NOTE: 1METER = 3.3 FEET
1 SQUARE METER = 10.8 SQUARE FEET

N/A - Not Available
-- - No Severity Levels
Numbers noted are average quantities for the given distress at the specified severity level.

TABLE 8 Comparisons for JCP

DISTRESS	UNITS	LOW M	LOW F	MED M	MED F	HIGH M	HIGH F	TOTAL M	TOTAL F
CRACKING									
CORNER BREAKS	NUMBER	0	0	0	0	0	0	0	0
DURABILITY "D"	SQUARE METERS	0	0	0	0	0	0	0	0
LONGITUDINAL	METERS	3.52	0.71	0	0	0	0	3.52	0.71
TRANSVERSE	METERS	3.53	1.41	2.16	2.7	0.7	1.24	6.4	5.34
JOINT DEFICIENCIES									
JOINT SEAL DAMAGE	METERS	50	0	6.92	0	9.94	0	66.8	0
SPALLING OF LONG. JOINTS	METERS	0.51	1.89	0.02	0.07	0	0	0.39	1.95
SPALLING OF TRANS. JOINTS	METERS	0.47	2.17	0.02	0.12	0.08	0.02	0.93	2.41
SURFACE DEFECTS									
MAP CRACKING AND SCALING	SQUARE METERS	--	--	--	--	--	--	285	4.63
POLISHED AGGREGATE	SQUARE METERS	--	--	--	--	--	--	12.6	0
POP OUTS	NUMBER/SQUARE ME	--	--	--	--	--	--	0.19	0.17
MISCELLANEOUS DISTRESS									
BLOW UPS	NUMBER	--	--	--	--	--	--	0	0
FAULTING OF TRANS JTS.&CRKS	MILLIMETERS	--	--	--	--	--	--	N/A	N/A
LANE TO SHOULDER DROPOFF	MILLIMETERS	--	--	--	--	--	--	N/A	N/A
LANE TO SHOULDER SEPARATION	MILLIMETERS	--	--	--	--	--	--	0	0
AC PATCH DETERIORATION	SQUARE METERS	0.05	0.06	1.89	0.02	0.00	0	1.94	0.08
PCC PATCH DETERIORATION	SQUARE METERS	0	1.84	0	0	0	0	0	1.84
WATER BLEEDING & PUMPING	METERS	--	--	--	--	--	--	0.7	0

SIGNIFICANTLY DIFFERENT
M : MANUAL
F : FILM

NOTE: 1METER = 3.3 FEET
1 SQUARE METER = 10.8 SQUARE FEET

N/A - Not Available
-- - No Severity Levels
Numbers noted are average quantities for the given distress at the specified severity level.

TABLE 9 Comparisons for CRCP

DISTRESS	UNITS	LOW M	LOW F	MED M	MED F	HIGH M	HIGH F	TOTAL M	TOTAL F
CRACKING									
DURABILITY "D"	SQUARE METERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONGITUDINAL	METERS	1.8	0.0	0.4	0.0	0.0	0.0	2.2	0.0
TRANSVERSE	METERS	449.6	247.0	11.2	89.0	0.0	5.6	483.4	341.6
SURFACE DEFECTS									
MAP CRACKING AND SCALING	SQUARE METERS	--	--	--	--	--	--	51.5	3.0
POLISHED AGGREGATE	SQUARE METERS	--	--	--	--	--	--	0.0	0.0
POP OUTS	NUMBER/SQUARE ME	--	--	--	--	--	--	0.6	0.3
MISCELLANEOUS DISTRESSES									
BLOW UPS	NUMBER	--	--	--	--	--	--	0.0	0.0
CONSTRUCTION JOINT DAMAGE	NUMBER	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
LANE TO SHOULDER DROPOFF	MILLIMETERS	--	--	--	--	--	--	N/A	N/A
LANE TO SHOULDER SEPARATION	MILLIMETERS	--	--	--	--	--	--	0.2	0.0
AC PATCH DETERIORATION	SQUARE METERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCC PATCH DETERIORATION	SQUARE METERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUNCHOUTS	NUMBER	0.6	0.0	0.0	0.0	0.0	0.0	0.6	0.0
SPALLING OF LONG. JOINTS	METERS	0.0	2.4	0.0	0.0	0.0	0.0	0.0	2.4
WATER BLEEDING & PUMPING	METERS	--	--	--	--	--	--	0.0	0.0
LONG. JOINT SEAL DAMAGE	METERS	--	--	--	--	--	--	N/A	N/A

SIGNIFICANTLY DIFFERENT (shaded)
M : MANUAL
F : FILM

NOTE: 1METER = 3.3 FEET
1 SQUARE METER = 10.8 SQUARE FEET

N/A - Not Available
-- - No Severity Levels
Numbers noted are average quantities
for the given distress at the specified severity level.

As previously noted, measurements of faulting, lane to shoulder dropoff, or any distresses requiring measurement of a difference in vertical position cannot be accommodated by the film. These measurements are readily available from manual surveys, however. This creates a significant difference between the two methodologies. Procedures currently are being evaluated to capture some of these data in an automated fashion, but none have been implemented to date.

The distress quantities for most of the low-severity surface defects are considerably lower on the film than on the manual surveys. This finding tends to substantiate the concerns about the ability to discern minimal differences in color and contrast between the film and the field surveys. This limitation tends to become less dramatic as the severity levels of these surface defects increase. As seen from the differences in recording joint seal deterioration, however, these same limitations make it virtually impossible to get an accurate reading of this distress from the film. Like faulting, lane to shoulder dropoff, and the distresses discussed previously, joint seal deterioration is supposed to be recorded for all sections. As can be seen from Table 8, however, no observations of this distress have been made.

These limitations with perception of color and contrast also tend to create some differences in the interpretation of patches or their associated deterioration, or both. As shown in Table 8, in some instances patches were perceived on the film where none existed and in other instances no patch could be detected where one was known to exist. These are fairly extreme cases in this particular limitation, which occurred only in a few instances. The dimensions of patches typically are large enough that it takes only a couple of errant patches to distort these figures fairly significantly.

CONCLUSIONS

Surface distress is commonly perceived to be one of the primary indicators of pavement performance. As such, the collection of these data for the LTPP program is a fairly significant aspect of this overall effort—so significant in fact that substantial efforts have been made in the development of a distress identification manual and guidelines for the measurement and recording of these distresses, along with elaborate accreditation procedures to provide for the most uniform and consistent data possible.

To further ensure that adequate observations of these data are obtained, two methods of data collection are utilized. The primary method of distress data collection for the LTPP program is from the digital analysis of 35-mm film taken of each test section on a routine basis. As a backup, manual surveys are conducted as needed. The LTPP program places a high emphasis on the quality and consistency of the data collected on these test sections. Differences in data collected through other programs with lesser emphasis on quality may be considerably greater than those presented in this paper.

In reviewing the distress data collected to date, two primary conclusions can be drawn. Table 10 has been prepared to summarize all of the observations noted in this paper. The first and probably most significant observation is that few of these test sections have much distress. Some of the distresses occur more commonly than others. There are a variety of explanations for why some of these distresses may not exist, as discussed previously in greater detail. The conclusion, however, is that there still is not much distress on these sections to analyze.

The second conclusion that can be drawn from these data is that there are definitely distinct differences in the distress data collected by the two methods. Again, there are various reasons for why these differences exist. To ensure that the data are not misused, it is important to recognize these differences when using the data.

The limitations of and distinctions between the two methods of distress data collection noted in this paper are not intended to imply that one methodology is more appropriate than the other.

TABLE 10 Summary of Observations

ASPHALT	SEVERITY			JOINTED	SEVERITY			CONTINUOUSLY REINFORCED	SEVERITY		
	L	M	H		L	M	H		L	M	H
CRACKING				CRACKING				CRACKING			
FATIGUE	F	F	F	CORNER BREAKS	B	B	B	DURABILITY "D"	ND	ND	ND
BLOCK	F	ND	ND	DURABILITY "D"	ND	ND	ND	LONGITUDINAL	F	F	ND
EDGE	F	ND	ND	LONGITUDINAL	F	ND	ND	TRANSVERSE	F	M	M
LONGITUDINAL	B	B	ND	TRANSVERSE	F	B	M	SURFACE DEFECTS			
REFLECTIVE	M	ND	ND	JOINT DEFICIENCIES				MAP CRACKING & SCALING	–	F	–
TRANSVERSE	M	B	B	JOINT SEAL DAMAGE	F	F	F	POLISHED AGGREGATE	–	ND	–
PATCHES AND POTHOLES				SPALLING OF LONG. JOINTS	M	B	ND	POPOUTS	–	B	–
PATCH DETERIORATION	F	B	ND	SPALLING OF TRANS. JOINTS	M	B	B	MISCELLANEOUS DISTRESS			
POTHOLES	B	ND	ND	SURFACE DEFECTS				BLOWUPS	–	ND	–
SURFACE DEFORMATIONS				MAP CRACKING & SCALING	–	F	–	CONSTRUCTION JOINT DAMAGE	B	ND	ND
RUTTING	–	ND	–	POLISHED AGGREGATE	–	F	–	LANE TO SHOULDER DROPOFF	–	ND	–
SHOVING	–	ND	–	POPOUTS	–	B	–	LANE TO SHOULDER SEPARATION	–	B	–
SURFACE DEFECTS				MISCELLANEOUS DISTRESS				PATCH DETERIORATION	B	ND	B
BLEEDING	F	ND	ND	BLOWUPS	–	ND	–	PUNCHOUTS	B	ND	ND
POLISHED AGGREGATE	–	ND	–	FAULTING OF TRANS JTS & CRKS	–	ND	–	SPALLING OF LONG. JOINTS	M	B	ND
RAVELING & WEATHERING	F	ND	ND	LANE TO SHOULDER DROPOFF	–	ND	–	WATER BLEEDING & PUMPING	–	ND	–
MISCELLANEOUS DISTRESS				LANE TO SHOULDER SEPARATION	–	B	–				
LANE TO SHOULDER DROPOFF	–	ND	–	PATCH DETERIORATION	M	F	B				
WATER BLEEDING & PUMPING	–	F	–	WATER BLEEDING & PUMPING	–	ND	–				

LEGEND:

B IDENTIFIABLE FROM EITHER METHOD
F MANUAL OK, FILM MARGINAL
M FILM OK, MANUAL MARGINAL
F UNIDENTIFIABLE FROM FILM SURVEYS
M UNIDENTIFIABLE FROM MANUAL SURVEYS
ND LESS THAN 2 % OF THE SECTIONS HAD THIS DISTRESS

Instead, the paper should serve to document those areas in which additional research and development may be warranted to improve on the methodologies employed. Most important, however, it is intended to highlight the importance of not relying too heavily on either method alone.

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