Accreditation of Strategic Highway Research Program Long-Term Pavement Performance Pavement Distress Raters

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Distress surveys are one element of the monitoring effort currently under way by the Strategic Highway Research Program (SHRP) for the Long-Term Pavement Performance (LTPP) study. Because accurate data are key to the success of the LTPP study, SHRP has developed and implemented an accreditation process to ensure the quality of distress data collected from manual surveys. The purpose of SHRP's accreditation process is to provide a means for ensuring, to the extent possible, the quality and consistency of distress data being collected by the raters. The process consists of two parts, a written examination and a two-part field survey examination, and is being administered in a workshop situation. Although the process is still in its early stages, it is SHRP's intent that all distress data for the LTPP study be collected by raters who have successfully completed the accreditation. The SHRP accreditation process and the results of its implementation to date are discussed.

Efforts of the Strategic Highway Research Program (SHRP) to monitor surface distress on the test sections under study in the Long-Term Pavement Performance (LTPP) research serve two primary purposes. The first is to provide a permanent, objective, high-resolution record of pavement condition over the full length and width of the sections under study; the second is to provide detailed, distress-specific condition data for use in the development of pavement performance prediction models.

To achieve these objectives, SHRP is making use of the PASCO Roadrecon photographic distress survey technology, which provides for high-resolution 35-mm black and white photographs and photographic transverse-profile measurements (*1*). The reduction of distress data from the PASCO film is accomplished through a computer-assisted interpretation process (*2*). The film interpretations and the initial quality assurance (QA) of the interpretations are performed under close supervision of experienced engineers and technicians in an office environment. Further QA of the film interpretations is performed at the SHRP regional coordination offices (RCOs) by the personnel most knowledgeable of the actual conditions at the sites.

In those instances in which the PASCO units cannot be used because of time constraints or the difficulty of getting the PASCO survey vehicles to the site, a manual distress survey serves as the backup data collection method (*3*). These surveys do not have the same level of thorough supervision and QA checking as are available in the film interpretation process. Another important facet of the manual survey is that no permanent objective records, such as photographs obtained in a consistent and controlled manner, are left behind to supplement the hand-drawn maps, observations, and interpretations (possibly subjective) of the rater.

Consequently, an accreditation process to develop consistency among raters has been established by SHRP. The specific purpose of this accreditation process is to provide a means for ensuring, to the extent possible, the quality and consistency of distress data that are collected for the LTPP program by the RCO raters. Although the process is still in its early implementation phase, it is SHRP's intent that all distress data for the LTPP study be collected by raters who have successfully completed the accreditation.

This paper describes the LTPP accreditation process and its implementation to date. The first part of the paper presents an overview of the accreditation procedure, including its basis, components, and grading system. The next portion of the paper focuses on two workshops conducted by SHRP in May and June 1992 as part of the implementation process. Particular emphasis is placed on the changes to the accreditation process that resulted from these workshops. Finally, the major conclusions to date and recommendations for improving the overall process and its implementation are presented in the last portion of this paper.

ACCREDITATION PROCEDURE

Achieving the desired consistency in distress data collection requires a basis for the actual identification, measurement, and recording of distresses. Pavement distresses are defined and measurement and recording requirements are established in SHRP's *Distress Identification Manual for the Long-Term Pavement Performance Studies* (DIM) (*4*). Manual distress surveys are performed using the procedures published in an appendix of the DIM. This appendix contains instructions for performing manual surveys, standard map symbols for recording distress occurrences, map sheets, and distress data summary sheets. The maps are prepared in the field by the rater and all distress quantities are then summarized and re-

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corded on distress survey summary sheets appropriate for the pavement type.

The importance of the distress data to the goals of the LTPP program require minimum levels of experience and expertise for the personnel performing the surveys. To participate in the accreditation process, and hence future distress data collection activities, RCO raters must have the following: high school education (or equivalent), previous training in distress surveys (either formal or informal), and familiarity with the LTPP DIM and field data collection procedures. Previous field experience (minimum of 1 year) is highly desirable but not mandatory.

The actual accreditation process consists of two major parts (5): a written examination and a two-part field survey examination. The written examination is intended to test the general knowledge of the rater. The examination consists of the following:

- Identification of distresses from slides: 60 slides are shown to the RCO raters, covering various distress types on asphalt-surfaced, jointed concrete and continuously reinforced concrete pavements. The raters are allowed 20 sec to identify the distress type(s) shown in each slide. This portion of the examination is 20 min in length and is worth 25 percent of the total written exam.
- Knowledge of distress types, severities, and measurement procedures: RCO raters are required to answer a total of 10 short-answer questions covering the description of distress types, severity-level definitions, or field measurement procedures, or all of these. This part of the examination is 45 min in length and is worth 60 percent of the total written exam.
- Interpretation of distress maps: RCO raters are required to summarize distress types and quantities from a map sheet. This portion of the examination is 20 min in length and is worth 15 percent of the total written exam.

If a rater fails to achieve the minimum grade, review sessions are held and a reexamination using different questions is conducted. If after the second attempt the rater cannot pass the written examination, the rater is not accredited.

The field survey examinations are intended to measure the capabilities of the raters in observing and recording distress data. They are conducted on two 150-m pavement sections: one surfaced with asphalt concrete and one with portland cement concrete. These sections will have been surveyed in detail by a committee of experienced raters, including the accreditation workshop leaders and other knowledgeable personnel, to determine the extent and types of distresses present. The results of the committee surveys are considered the ground truth or the "actual values" against which the individual rater's results will be compared for grade.

Each RCO rater is required to independently perform a distress survey of the sections included in the accreditation process. These surveys are performed using LTPP procedures; that is, detailed scaled mapping of the section followed by reduction of the mapped quantities and completion of the appropriate distress summary forms. At each accreditation section, the RCO raters are allowed 3 hr to complete the survey and to reduce the distress data for each section.

Grading the distress surveys is accomplished by comparing the individual rater's results to the actual values determined by the committee of experienced raters. The point value system used for grading consists of a maximum of 10 points for each distress type actually in the section. These 10 points are distributed among the individual severity levels, where applicable, as well as the total quantity of the distress type. Accuracy in identifying and recording distress determines the number of points received for each severity level and for the total. In turn, accuracy is determined by comparing the variance of the rater's results to those from the committee of experienced raters (i.e., ground truth quantities). The point values received on the basis of variance between committee and rater observations are calculated as follows:

$$\text{Points} = \left(1 - \frac{\text{actual} - \text{rater}}{\text{actual}}\right) \times \text{QtyWgt}$$

where

actual = quantity of distress from committee survey,
rater = quantity observed and recorded by rater, and
QtyWgt = quantity weight factor applied to total and to each severity level (QtyWgt = 7 for total quantity of distress and 0.5, 1.0, and 1.5 for the total quantity of low, moderate, and high-severity distress, respectively).

As an example, assume a rater recorded 60 m^2 of alligator cracking in the section. Of this total, 20 m^2 was of low severity and 40 m^2 was of medium severity. The actual values totaled 80 m^2: 30 m^2 of low severity and 50 m^2 of moderate severity. Thus, the rater's grade for this particular distress is as follows:

				Points	
Total Quantity	*Actual*	*Rater*	*Variance (%)*	*Possible*	*Actual*
Distress	80.0	60.0	25.0	7.0	5.3
Low severity	30.0	20.0	33.3	0.5	0.3
Moderate severity	50.0	40.0	20.0	1.0	0.8
High severity	0.0	0.0	0.0	1.5	1.5

The sum of the points from rating the variance is 7.9 out of a total possible of 10 points. Also note that if there is no distress at one severity level, the correct determination that no distress is present is given full credit.

The total number of points received for each distress type is then weighted for the significance of the distress. Table 1, for example, presents the weight factors for all distress types for AC-surfaced pavements. Thus, for the above example, an additional weighting factor of 5 (for alligator cracking, see Table 1) is applied to the number of points computed on the basis of the rater variance. Or the maximum possible number of points for this distress type is equal to the distress weight (5) times the maximum number of points gained from complete accuracy in recording (10), or 50 points. When the variance rating is weighted for the distress type, the points-received value becomes 39.5 out of a maximum possible 50.

Deductions also are imposed on the sum of points received for all distress types when the rater misses a distress type or records a distress type not identified by the committee. This deduction is set at 2 percent of the total number of possible points in the section and is assessed for each occurrence of

TABLE 1 AC Pavement Distress Assessment Parameters

DISTRESS TYPE	UNIT	WEIGHT
Cracking		
1. Alligator (Fatigue) Cracking	Square Meters	5
2. Block Cracking	Square Meters	5
3. Edge Cracking	Meters	5
4. Longitud. Cracking - Edge		
Length	Meters	5
Length Sealed	Meters	0.5
4. Longitud. Cracking - Other		
Length	Meters	5
Length Sealed	Meters	0.5
5. Reflection Cracking at Joints		
Number	Number	5
Length (Transv. Joints)	Meters	3
Length Sealed (Transv.)	Meters	0.5
Length (Longt. Joints)	Meters	3
Length Sealed (Longt.)	Meters	0.5
6. Transverse Cracking		
Number	Number	5
Length	Meters	3
Length Sealed	Meters	0.5
Patching and Potholes		
7. Patch/Patch Deterioration		
Number	Number	2
Area	Square Meters	1
8. Potholes		
Number	Number	2
Area	Square Meters	1
Surface Deformation		
9. Rutting	Millimeters	2
10. Shoving		
Number	Number	2
Area	Square Meters	2
Surface Defects		
11. Bleeding	Square Meters	0.5
12. Polished Aggregate	Square Meters	0.5
13. Raveling and Weathering	Square Meters	0.5
Miscellaneous Distress		
14. Lane-to-Shoulder Dropoff	Millimeters	2
15. Lane-to-Shoulder Separation		
Length	Meters	2
Length Sealed	Meters	0.5
16. Water Bleeding and Pumping		
Number	Number	2
Length	Meters	1

missed or made-up distress. The final grade is the ratio of adjusted points received (points received minus deductions) to the maximum possible in the section:

$$\text{Grade}_i = 15 + \frac{\sum_{j=1}^{m} (\text{DstWgt}_j \times \text{points}_j) - \sum_{k=1}^{n} \text{deducts}_k}{\sum_{j=1}^{m} \text{DstWgt} \times \text{points}_{\text{max},j}}$$

where

grade_i = final grade for section surveyed by ith rater,
DstWgt_j = distress weight applied to jth distress,
points_j = points received by rater for jth distress,
$\text{points}_{\text{max},j}$ = maximum possible number of points for jth distress, and
deducts_k = deduct points for kth distress (missed or not identified).

A complete example of the field accreditation scoring system is presented in Table 2 for an AC-surfaced pavement.

Also note that a constant (i.e., 15 points) was introduced in the equation to allow for, in a very crude fashion, "reasonable" deviations from the ground truth values so that the raters are not unduly penalized. This value was established on the basis of the results of the pilot workshop, which are discussed later. However, because experience with the anticipated variability of the measurements is gained through future implementation of the accreditation process, it is recommended that a measure of variability (e.g., actual value ± one standard deviation for each distress type) be included in the scoring system, instead of using a somewhat arbitrary constant. In the interim, it is recommended that, for each accreditation site, a constant (say, 10 to 20 points) derived on the basis of the variance results of a committee of experienced raters be used for grading purposes.

In terms of the overall accreditation grade, the written examination is worth 20 percent of the total score, whereas the field survey portion is worth 80 percent. To receive accreditation, a rater must achieve a combined 75 percent grade for the written and field examinations, but no less than 70 percent on either portion. The passing grades noted are expected to affirm the competence of the raters in distress data collection.

TABLE 2 Example of Accreditation Grading System for Field Surveys: AC-Surfaced Pavements

Distress Type	Units	Rater Observations				Actual Quantities *				Scoring Summary		
		Total	Low	Mod.	High	Total	Low	Mod.	High	Possible Points	Points Received	Deduct Points
Cracking												
1. Alligator Cracking - Area	Square Meters	17.8	0.4	17.4	0.0	14.9	1.9	13.0	0.0	50.0	39.2	0.0
4. Longitudinal Cracking: Edge - Length	Meters	4.7	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7
4. Longitudinal Cracking: Other - Length	Meters	86.3	21.3	39.7	25.3	89.1	22.1	44.0	23.0	50.0	47.6	0.0
4. Longitudinal Cracking: Other - Length Sealed	Meters	0.0	0.0	0.0	0.0	0.8	0.8	0.0	0.0	5.0	0.0	3.7
6. Transverse Cracking - Number	Number	52	21	17	14	56	25	20	11	50.0	44.3	0.0
6. Transverse Cracking - Length	Meters	77.7	20.0	29.0	28.7	74.6	21.8	28.2	24.6	30.0	28.2	0.0
6. Transverse Cracking - Length Sealed	Meters	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
								Totals:		185.0	159.3	7.4
											Grade:	97.1

* Based on control group survey

ACCREDITATION WORKSHOPS

The accreditation of RCO raters is being administered by SHRP in a workshop situation. The raters are brought to a single location for 1 week of classroom and field work. The workshop agenda covers classroom sessions, field survey exercises, field survey examinations, and written examination.

Classroom sessions are limited in scope because of the level of experience required for attendance. Primary emphasis is on any changes or revisions to the DIM and field procedures. However, a general review of distress types is conducted using slides and video to reinforce the attendees' knowledge of the most current DIM and field procedures. Time is available for questions and any discussion required to help raters clearly understand the subject matter.

Field survey exercises are conducted as a calibration of the raters. For each pavement type, short pavement sections (60 to 90 m) will have been selected and surveyed by the committee of experienced raters before the start of the workshop. On each of these sections, the RCO raters are required to identify and measure the distresses present. Sections in the early portion of the field exercises are more complex to identify the level of experience of the raters and areas of confusion and error that should be addressed in additional review and discussion. The next test section consists of fewer examples of distresses, with additional time spent in detailed walkdown of the site and discussion of the individual distresses. The objective of these surveys is to determine the individual rater's bias and, as necessary, retrain or correct that individual's misperceptions. The use of field surveys is superior to photographs or video in this determination.

The field survey and written examinations are, as indicated earlier, intended to appraise the capabilities of RCO raters in observing and recording distress data and to assess their specific knowledge of the field procedures and distress definitions. The field survey examinations are conducted after completion of the field survey exercises for each pavement type, scheduled at the end of the second and fourth days, whereas the written examination is administered on the last day of the workshop.

To date, the SHRP accreditation workshop has been conducted twice, both times in Reno, Nevada. Reno was selected for climatic reasons (very little rainfall), thus minimizing delays or postponement of field activities associated with the workshop. The first workshop took place in May 1992 and the second one in June 1992. Both of these workshops are discussed next, along with a summary of the major observations and conclusions.

Pilot Workshop

Before the pilot workshop, various planning activities were undertaken by SHRP to ensure the success of this and future workshops. To assist in these activities, an accreditation committee was formed to finalize all workshop plans, materials, and selection of survey sections. This committee was composed of representatives from SHRP, SHRP contractors, FHWA, and Texas Department of Transportation. The initial activity consisted of visits to potential test sites to assess their suitability for use in the workshop. This effort resulted in the selection of the following sections:

- Lemon Drive, Lemon Valley, Nevada—complex and simple sections, AC-surfaced pavements.
- McCarren Boulevard, westbound (SHRP General Pavement Study Section 321021); Reno, Nevada—accreditation section, AC-surfaced pavement.
- Interstate I-80 westbound, Hirschdale, California—complex section, jointed concrete pavement.
- US-395, southbound, Reno, Nevada—simple and accreditation sections, jointed concrete pavement.

Once the site selections had been made, it was decided that a control group was necessary to provide detailed distress surveys for the test sections chosen for the workshop. This group consisted of the accreditation committee members and one representative from each of the four SHRP regions, each ostensibly the most knowledgeable distress rater at that RCO office. Their results, as noted earlier, would serve as the ground truth distress data against which the individual rater's results would be compared for grade.

The pilot workshop took place during May 1992. Although the ultimate goal of the workshop was the accreditation of RCO raters, several other objectives were targeted during this workshop:

- To determine the feasibility of the planned accreditation workshops,
- To assess the grading system developed for the accreditation of the RCO raters,
- To assess RCO rater variability, and
- To establish actual or ground truth distress data for use in near-future workshops.

To allow for site selection and general setup activities before the arrival of the RCO raters, this workshop was limited to 3 days. The accreditation committee met during the 2 days before the pilot workshop to select the survey sites and to finalize workshop plans and materials. For the 3-day workshop, this committee was joined by the remainder of the control group members, the RCO representatives.

Classroom activity, significantly shortened to fit within the 3-day time frame, was limited to review of the DIM revisions and new data forms. Field activities consisted of individual distress surveys of the complex sections, conducted by each member of the control group, followed by a walkdown of the sites and discussion of the distresses observed. Although it was intended that a group survey would be conducted on the complex sites, insufficient time was available because of the tight schedule and traffic control restrictions.

A thorough review and discussion of the results for the complex sections led to a number of changes to the SHRP distress identification manual (i.e., DIM), which were aimed at eliminating the ambiguity associated with some of the distress definitions. Once these issues had been resolved, individual surveys were performed by the control group raters on the accreditation sites (time did not permit individual or group surveys of the simple sections). The results of the accreditation site surveys, and in particular rater variability, were also reviewed and discussed before conduct of the control group surveys for the accreditation sites, which was the last field activity for each pavement type. Both the accreditation committee and RCO raters walked the sections as a group, identifying all distresses present and mapping them. Where disagreements occurred, the alternate viewpoints were discussed by the group before reaching a final decision.

The last pilot workshop activity was the written examination, which included the identification of distresses from slides and short-answer questions relating to distress definitions and field procedures. Although initially envisioned as an open-book exam because RCO raters must have the DIM with them when conducting LTPP surveys, it was decided to proceed with a closed-book examination. This did not seem to be a problem, as all RCO raters scored very high in the exam (more than 90 percent). It was also decided by the accreditation committee to add to the examination a question dealing with the interpretation and summary of distresses from maps.

Overall, the pilot accreditation workshop is considered a success, as all targeted objectives were satisfactorily completed. The concept of accreditation workshops for SHRP-LTPP RCO raters was shown to be feasible; measures of rater variability were established (albeit limited); the grading system was shown to work satisfactorily, although changes will be required in the future to account for the inherent variability associated with subjective ratings; and ground truth values were established for the accreditation sites that will be used in future workshops. Besides the ambiguity problems associated with the DIM and their impact on the individual accreditation surveys, the only other difficulty encountered in the workshop was the change in measurement units from English, to which the RCO raters were accustomed, to the International System of Units. This problem, however, was quickly overcome after the first couple of surveys.

First Full-Scale Workshop

The first full-scale workshop took place during June 1992. Attendance was limited to three persons per region (i.e., total of 12 participants) to allow for adequate discussion time and to make field surveys easier. As a result, the classroom time was more than adequate to answer questions, and the field activities were completed within the time allotted.

On Day 1 of the workshop, the first activity consisted of approximately 3 hr of review and discussion of distresses in asphalt-surfaced pavements. Overhead transparencies of the definitions and sketches along with slides of actual examples of distresses were used to instruct attendees on the DIM. The final portion of the classroom session consisted of a presentation on specific procedures recommended for performing surveys, including the sequence of activities, setup of the forms, presurvey walkdown, and use of equipment all intended to help the raters perform systematic and reliable surveys in an efficient manner. Field activities commenced on the afternoon of Day 1 with individual surveys of a complex site located on Lemon Drive, north of Reno. A 90-m section was surveyed by each individual for comparison to the pilot workshop findings and to assess the relative abilities of the attendees. The time required for this exercise necessitated that detailed evaluation of individual results be conducted the following day.

On Day 2, the complex site on Lemon Drive was reviewed during a walkdown along with discussion directed at resolving differences in distress identification. In addition, examples of some distress types found outside the test sections were examined and discussed as a supplement to the classroom slide presentation. This activity was followed by individual surveys of a 60-m section, which allowed the raters to use the "adjusted" definitions; that is, the corrections and clarifications resulting from the complex section surveys and discussions. The afternoon of Day 2 consisted of the individual surveys of the 150-m accreditation site on McCarren Boulevard. All raters were given 3 hr to map and reduce the distresses for entry on distress data sheets.

Day 3 of the workshop consisted of morning classroom sessions for review of the results of the asphalt-surfaced pavement accreditation surveys followed by separate sessions on distresses found in continuously reinforced pavement and jointed portland cement concrete pavement. Overhead transparencies of the definitions and forms and slides of typical distresses were used in the same way as that for the asphalt-surfaced pavement classroom sessions to familiarize the raters with changes to the DIM. The afternoon of Day 3 consisted of field activities conducted in I-80 in California. A 90-m section of this highway was marked out for individual surveys of a complex jointed concrete pavement. Before the surveys, a group walkdown and discussion were held to orient the raters to the site conditions. Sufficient time was available for the raters to complete their surveys and then conduct another

group walkdown to discuss and compare the findings. This served to identify differences in interpretations of the defects observed as well as reinforcing and supplementing the classroom presentation.

Day 4 consisted of field activities on jointed concrete sections at the US-395 site in Nevada. In the morning, a 60-m section was surveyed by each rater. The results of the morning survey were discussed in a walkdown before departing the site and returning to the classroom. In the afternoon, the raters were returned to the site to perform individual surveys of the 150-m accreditation section, also on US-395.

Day 5 activities were conducted in the classroom. These consisted of a review of the jointed concrete pavement accreditation surveys followed by the written examination. The examination included identification of distress types from slides, short-answer questions on distress identification, and reduction of distresses from map sheets. Once the examination was completed, the raters were allowed to grade their own papers during a presentation and discussion of the correct answers to all questions.

Results

The distress survey results for the complex and accreditation sites at both workshops are given in Tables 3 through 6: Tables 3 and 4 summarize the results for the AC-surfaced pavement sections, whereas Tables 5 and 6 summarize those for the jointed concrete pavement sections. In each table, the mean and standard deviation for each distress type–severity level combination are given, along with the ground truth values where available. Because the pilot workshop was limited to 3 days, time permitted the conduct of group surveys for the accreditation sites only, not the complex and simple sections. Thus, only Tables 4 and 6 contain ground truth distress data. Time constraints during the pilot workshop also prohibited the conduct of individual or group surveys on the simple sections, so no results exist. Surveys on these simple sections were performed during the full-scale workshop but are not discussed in this paper because of the limited data; that is, no basis for comparisons and very little for discussion other than noting that rater variability was generally very good, as indicated by the small standard deviation.

From the information contained in these tables, the following observations and conclusions are made:

- AC-Surfaced Pavement—Complex Section (Table 3): In general, there is good agreement between the results from both workshops for this section. Significant differences do occur in the amount of alligator cracking and longitudinal cracking identified by the raters at each workshop. These differences, however, are almost exclusively caused by changes made to the DIM during the pilot workshop before the full workshop surveys. Because the DIM did not clearly distin-

TABLE 3 Between-Rater Statistical Summary: AC-Surfaced Pavement, Complex Site

Distress Type	Units	Severity Level	Actual Values *	Means		Standard Deviations	
				Pilot Workshop	First Workshop	Pilot Workshop	First Workshop
Alligator Cracking - Area	Sq. Meter	Low	n/a	5.1	8.4	5.4	9.4
		Moderate	n/a	8.8	14.6	3.9	6.4
		High	n/a	0.9	2.8	0.7	3.3
		Total	n/a	14.8	25.8	6.1	11.6
Longitudinal Cracking: Other - Length	Meters	Low	n/a	7.3	0.3	5.0	0.5
		Moderate	n/a	7.7	0.0	9.4	0.0
		High	n/a	1.5	0.5	1.5	1.2
		Total	n/a	16.4	0.8	11.8	1.2
Longitudinal Cracking: Other - Length Sealed	Meters	Low	n/a	0.2	0.4	0.5	0.6
		Moderate	n/a	0.0	0.8	0.0	1.8
		High	n/a	0.1	0.0	0.2	0.0
		Total	n/a	0.3	1.2	0.5	2.1
Transverse Cracking - Number	Number	Low	n/a	41.6	40.7	10.9	8.1
		Moderate	n/a	19.8	18.0	10.9	10.2
		High	n/a	3.4	0.7	4.3	0.8
		Total	n/a	64.8	59.3	8.8	4.3
Transverse Cracking - Length	Meters	Low	n/a	39.3	51.9	15.3	14
		Moderate	n/a	45.6	46.6	19.9	20.2
		High	n/a	10.2	2.4	13.7	2.7
		Total	n/a	95.1	100.8	19.5	17.5
Transverse Cracking - Length Sealed	Meters	Low	n/a	7.3	14.8	6.8	7.3
		Moderate	n/a	14.4	19.9	11.3	16.5
		High	n/a	5.4	1.2	12.9	1.7
		Total	n/a	27.1	35.9	22.5	23.6
Patch/Patch Deterioration - Number	Number	Low	n/a	0.1	0	0.3	0
		Moderate	n/a	0.1	0	0.3	0
		High	n/a	0.6	1	0.5	0
		Total	n/a	0.8	1	0.6	0
Patch/Patch Deterioration - Area	Sq. Meter	Low	n/a	<0.1	0	<0.1	0
		Moderate	n/a	<0.1	0	<0.1	0
		High	n/a	0.4	0.3	0.6	0.2
		Total	n/a	0.5	0.3	0.6	0.2
Ravelling and Weathering - Area	Sq. Meter	Low	n/a	104.0	0.0	147.3	0.0
		Moderate	n/a	50.0	54.0	111.8	120.8
		High	n/a	26.3	0.0	87.1	0.0
		Total	n/a	180.3	54.0	152.6	120.8

* Based on control group survey

TABLE 4 Between-Rater Statistical Summary: AC-Surfaced Pavement, Accreditation Site

Distress Type	Units	Severity Level	Actual Values *	Means		Standard Deviations	
				Pilot Workshop	First Workshop	Pilot Workshop	First Workshop
Alligator Cracking - Area	Sq. Meter	Low	1.9	10.0	4.8	9.4	5.2
		Moderate	13.0	6.0	15.1	6.8	11.8
		High	0.0	0.7	3.0	0.2	4.2
		Total	14.9	16.1	22.9	9.3	11.1
Longitudinal Cracking: Edge - Length	Meters	Low	0.0	6.3	0.0	8.6	0.0
		Moderate	0.0	2.3	0.0	3.3	0.0
		High	0.0	24.9	0.0	35.9	0.0
		Total	0.0	33.5	0.0	46.6	0.0
Longitudinal Cracking: Other - Length	Meters	Low	22.1	27.2	31.4	3.0	13.8
		Moderate	44.0	26.7	25.1	8.3	18.2
		High	23.0	26.9	34.6	6.6	21.6
		Total	89.1	80.8	88.8	3.2	14.6
Transverse Cracking - Number	Number	Low	25	27.0	28.2	3.4	7.5
		Moderate	20	11.5	11.8	4.7	4.7
		High	11	14.7	11.3	3.0	4.4
		Total	56	53.2	51.9	6.1	6.8
Transverse Cracking - Length	Meters	Low	21.8	24.5	27.7	3.4	10.6
		Moderate	28.2	19.1	21.5	6.1	10.3
		High	24.6	33.5	23.4	7.9	10.4
		Total	74.6	77.1	70.8	8.0	24.0

* Based on control group survey

TABLE 5 Between-Rater Statistical Summary: Jointed Concrete Pavement, Complex Site

Distress Type	Units	Severity Level	Actual Values *	Means		Standard Deviations	
				Pilot Workshop	First Workshop	Pilot Workshop	First Workshop
Longitudinal Cracking - Length	Meters	Low	n/a	18.7	25.3	9.6	6.4
		Moderate	n/a	51.5	56.9	21.2	12.2
		High	n/a	29.8	11.4	20.2	8.4
		Total	n/a	100.0	93.6	4.2	8.3
Longitudinal Cracking - Length Sealed	Meters	Low	n/a	0.5	0.3	0.8	0.6
		Moderate	n/a	0.2	0.6	0.5	1.0
		High	n/a	0.0	0.1	0.0	0.3
		Total	n/a	0.7	0.9	0.8	1.3
Transverse Cracking - Number	Number	Low	n/a	7.6	10.2	1.6	2.4
		Moderate	n/a	10.0	9.3	4.3	1.8
		High	n/a	2.6	0.6	2.7	1.4
		Total	n/a	20.2	20.0	2.4	2.6
Transverse Cracking - Length	Meters	Low	n/a	12.0	17.5	5.8	5.0
		Moderate	n/a	26.1	31.3	7.6	6.3
		High	n/a	8.5	1.7	9.8	3.7
		Total	n/a	46.6	50.5	5.0	3.9
Transverse Cracking - Length Sealed	Meters	Low	n/a	0.1	0.0	0.1	0.0
		Moderate	n/a	0.6	0.0	0.8	0.0
		High	n/a	0.0	0.0	0.0	0.0
		Total	n/a	0.6	0.0	0.8	0.0
Joint Seal Damage of Trans. Joints - Number	Number	Low	n/a	0.6	0.6	1.2	1.2
		Moderate	n/a	8.4	5.3	3.9	4.0
		High	n/a	5.8	6.2	3.5	4.8
		Total	n/a	14.8	12.1	0.4	5.5
Joint Seal Damage of Long. Joints - Number	Number	Total	n/a	2	1.8	0	0.4
Joint Seal Damage of Long. Joints - Length	Meters	Total	n/a	61.5	53.1	4.2	20.9
Spalling of Longitudinal Joints - Length	Meters	Low	n/a	0.2	3.3	0.4	10.4
		Moderate	n/a	0.0	3.8	0.0	12.5
		High	n/a	0.0	0.5	0.0	1.7
		Total	n/a	0.2	7.5	0.4	24.5
Spalling of Transverse Joints - Number	Number	Low	n/a	4.4	0.6	5.6	1.0
		Moderate	n/a	0.0	0.2	0.0	0.6
		High	n/a	0.0	0.2	0.0	0.6
		Total	n/a	4.4	0.9	5.6	1.0
Spalling of Transverse Joints - Length	Meters	Low	n/a	11.1	0.3	20.7	0.6
		Moderate	n/a	0.0	0.2	0.0	0.5
		High	n/a	0.0	0.1	0.0	0.1
		Total	n/a	11.1	0.5	20.7	0.7
Popouts - Number	Number	Total	n/a	220.6	114.8	609.6	590.1

* Based on control group survey

TABLE 6 Between-Rater Statistical Summary: Jointed Concrete Pavement, Accreditation Site

Distress Type	Units	Severity Level	Actual Values *	Means		Standard Deviations	
				Pilot Workshop	First Workshop	Pilot Workshop	First Workshop
Corner Breaks - Number	Number	Low	2	4.6	2.8	3.1	1.9
		Moderate	7	4.6	5.8	2.8	2.1
		High	0	0.8	0.3	1.2	0.6
		Total	9	10.0	8.8	1.1	1.2
Longitudinal Cracking - Length	Meters	Low	11.3	10.0	11.8	3.6	1.1
		Moderate	4.5	3.3	3.6	2.9	1.4
		High	3.0	1.3	0.3	1.1	1.1
		Total	18.8	14.7	15.7	4.9	1.1
Longitudinal Cracking - Length Sealed	Meters	Low	0.0	0.0	0.0	0.0	0.0
		Moderate	0.0	0.5	1.6	1.0	1.1
		High	3.0	1.3	0.2	1.1	0.7
		Total	3.0	1.8	1.8	0.9	1.1
Transverse Cracking - Number	Number	Low	0	0.8	0.8	0.4	0.6
		Moderate	1	0.6	1.1	0.8	1.0
		High	2	1.4	1.7	0.8	1.6
		Total	3	2.8	3.5	0.4	1.7
Transverse Cracking - Length	Meters	Low	0.00	3.0	2.5	1.5	1.8
		Moderate	3.70	1.5	3.7	1.9	3.7
		High	7.40	5.3	4.8	3.1	4.0
		Total	11.1	9.8	11.0	2.9	2.1
Transverse Cracking - Length Sealed	Meters	Low	0.0	0.0	0.0	0.0	0.0
		Moderate	3.7	0.0	2.5	0.0	3.1
		High	7.4	3.7	4.4	3.3	3.9
		Total	11.1	3.7	6.9	3.3	3.1
Joint Seal Damage of Trans. Joint - Number	Number	Low	32	31.8	32.1	0.4	0.3
		Moderate	0	0.2	0.0	0.4	0.0
		High	0	0.0	0.0	0.0	0.0
		Total	32	32.0	32.1	0.0	0.3
Spalling of Longitudinal Joints - Length	Meters	Low	15.0	17.4	12.2	11.2	5.6
		Moderate	0.0	0.2	1.1	0.3	0.8
		High	0.0	0.0	0.2	0.0	0.3
		Total	15.0	17.5	13.5	11.2	6.0
Spalling of Transverse Joints - Number	Number	Low	2	5.4	0.5	3.4	1.1
		Moderate	0	2.6	0.0	3.3	0.0
		High	0	0.2	0.2	0.4	0.6
		Total	2	8.2	0.7	5.1	1.3
Spalling of Transverse Joints - Length	Meters	Low	0.6	2.3	0.1	1.1	0.2
		Moderate	0.0	0.9	0.0	1.2	0.0
		High	0.0	0.1	0.1	0.1	0.1
		Total	0.6	3.3	0.2	1.7	0.3
Popouts - Number	Number	Total	18	1.8	28.2	2.2	14.3

* Based on control group survey

guish between low-severity alligator cracking and longitudinal cracking (other than construction) in the wheelpath, it was collectively decided at the pilot workshop that single, longitudinal cracks within the wheelpath should be defined as low-severity alligator cracking. Thus, the differences shown in Table 3 reflect the impact of the DIM change on the survey results. The only other major difference occurred in the amount of raveling and weathering, where significantly higher quantities were identified by the raters at the pilot workshop. This difference is attributed to the lack of familiarity of the raters with the construction materials used at the site and the effect of studded tires on the pavement surface, both of which were explained before the full workshop surveys.

- AC-Surfaced Pavement—Accreditation Section (Table 4): Unlike the previous section, ground truth distress data were available for this accreditation site in addition to the results from the individual surveys performed during the two workshops. With the exception of longitudinal cracking (edge or construction), there is excellent agreement among all raters within and between workshops, as reflected by the similar means and low standard deviations. Even the differences in longitudinal cracking are somewhat misleading in that only one (out of four) RCO rater at the pilot workshop incorrectly identified this distress type, instead of alligator cracking, which was the "correct" distress. There are also small differences in the quantities of alligator cracking shown in Table 4, but these are almost entirely because of differences in the way widths were defined by the raters for low-severity alligator cracking (generally a single crack). Guidelines for measuring these widths were developed during the full workshop as a result of the observed differences and will be implemented in future workshops.
- Jointed Concrete Pavement—Complex Section (Table 5): Survey results for this section were similar for both the pilot and first full workshops. The major differences between the two were in the quantities of joint spalling and popouts identified by the RCO raters in the respective workshops. These differences are also attributed to the DIM changes that took place after the pilot surveys but before the full workshop surveys; thus, they were to be expected. Otherwise, the two sets of surveys are in excellent agreement. Furthermore, it is noted that the standard deviation is generally low for most distress-type–severity level combinations, indicating consistency among all raters.
- Jointed Concrete Pavement—Accreditation Section (Table 6): The results for this section are similar to those of the

complex section in that, with few exceptions, they were similar for both workshops. In addition, the results are also similar to the ground truth values established by the control group, particularly those from the full workshop. In general, the major differences between the pilot survey results and those of the control group and the full workshop surveys are a result of changes to the DIM made after the pilot surveys. To a lesser degree, some of the differences can simply be attributed to rater variability. Overall, the results of these accreditation surveys are quite good in that they show very consistent, uniform results among the raters, that is, similar means and low standard deviations for most distress-type–severity level combinations.

Overall, the rater variance for the first full-scale workshop was slightly lower than that of the pilot workshop. It is hypothesized by the authors that this is because of (a) changes made to the DIM identification and quantification procedures during the pilot workshop; (b) greater emphasis by the instructors at the full-scale workshop on certain distress types that were found to be a problem during the pilot workshop; and (c) changed pavement conditions (surface temperatures at the pilot workshop were significantly lower than those at the full-scale workshop).

Looking now at how these survey results translate into grades, and hence the accreditation of the 16 RCO raters who participated in the workshops, Table 7 summarizes the scores received by the raters for each accreditation site and the written examination as well as the final (composite) accreditation grade. All scores are based on a scale of 0 to 100, with 100 being excellent. For the most part, the scores are in the good-to-excellent range (80 to 100 percent). Also, the composite score for all RCO raters exceeded 75 percent, whereas their individual survey and written examination grades exceeded 70 percent, thus satisfying the accreditation criteria established by SHRP. These results were by no means unexpected as all raters involved in the workshops had 2 or more years of experience in the conduct of field distress surveys using SHRP procedures. The workshop results were also encouraging in terms of the consistency of the distress data being collected by the RCO contractors.

SUMMARY AND CONCLUSIONS

The purpose of SHRP's accreditation process is to provide a means for ensuring, to the extent possible, the quality and consistency of distress data being collected by the RCO raters. The process consists of two parts: a written examination and a two-part field survey examination. The successful completion of these examinations will identify the rater as possessing the knowledge, competence, and accuracy to provide distress data of acceptable reliability for inclusion in the LTPP data base. Although the process is still in its early stages, it is SHRP's intent that all distress data for the LTPP study be collected by raters who have successfully completed the accreditation.

The SHRP accreditation process is being administered in a workshop situation, involving both classroom and field work. To date, the workshop has been conducted on two separate occasions, both in Reno, Nevada. The first, a pilot workshop, took place in May 1992, and the other in June of 1992. Although the ultimate objective was the accreditation of RCO raters, several other objectives were targeted during these workshops and successfully completed:

- The concept of accreditation workshops for RCO raters was shown to be feasible;
- Preliminary measures of rater variability were established;
- The accreditation grading system was shown to work satisfactorily, although changes will be required to account for the subjective nature of distress surveys; and
- Ground truth distress values were established for two accreditation sites that will be used in future workshops.

TABLE 7 Accreditation Workshop Scores

Workshop	RCO Rater ID	Flexible Section	Rigid Section	Written Examination	Final Grade
Pilot Workshop	1	82	80	92	83
	2	82	70	90	79
	3	99	81	96	91
	4	72	88	97	83
	Average:	84	80	94	84
	Std. Dev.:	10	6	3	4
Full Workshop	1	85	99	98	93
	2	73	80	93	80
	3	79	71	96	79
	4	70	79	90	78
	5	99	88	88	92
	6	77	83	80	80
	7	86	97	94	92
	8	85	76	83	81
	9	84	81	90	84
	10	97	94	91	95
	11	92	73	93	85
	12	75	77	89	79
	Average:	84	83	90	85
	Std. Dev.:	9	9	5	6
Combined Statistics	Average:	84	82	91	85
	Std. Dev.:	9	8	5	6

In terms of the ultimate objective, all 16 RCO raters who attended the workshops successfully completed the accreditation process (i.e., satisfied the accreditation criteria established by SHRP). This is not surprising since the RCO raters who participated in the accreditation workshops have had several years of experience in the conduct of SHRP distress surveys. Thus, another measure of the success of the accreditation process will come as additional workshops are conducted involving less-experienced personnel.

Another important outcome resulting from the initial accreditation workshops were revisions to the SHRP distress identification manual. In all cases, the changes to the manual were made to eliminate as much as possible the ambiguity associated with some of the distress definitions. Further revisions to the manual may be required as experience with distress surveys is gained.

Finally, although the accreditation process has proven quite successful so far, improvements can be made in a number of areas:

- Revision of the accreditation scoring system for the field examination to incorporate the inherent variability associated with subjective distress surveys; that is, a measure of the anticipated variability, as determined from several workshops, should be included in the scoring system.
- Inclusion of a continuously reinforced concrete pavement section as part of the field examinations. Such a section was not included in the initial workshops for two reasons: (a) there were no such sections within the vicinity of Reno and (b) there were time constraints.
- Because many distresses have the tendency to take on certain appearance characteristics on the basis of climatic (regional) conditions, it may be worthwhile to establish several accreditation sites (e.g., one for each SHRP RCO) throughout the country, with the workshops alternating from one site to another. This would expose the RCO raters to different appearances of the same distress type.

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