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UKTRP-87-18

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ABSTRACT

Lexington, in central Kentucky, is the second largest city in the state. Local government is by a mayor and council of elected representatives from twelve districts and three at-large representatives. The Department of Public Works headed by a Commissioner, who reports to the mayor and city-county council, administers the streets and roads system.

The street and road network in Lexington consists of approximately 720 centerline miles. Approximately 100 miles are rural in nature and 620 miles are urban. Approximately 95 percent are bituminous surfaced roads; a majority of the remainder is constructed of portland cement concrete.

Increasing costs for constructing and maintaining the street and road network was a stimulus to implement a systematic pavement and road surface management system. Available alternatives were reviewed, and it was decided to maximize in-house resources of the Lexington-Fayette Urban County Government. Meetings with public works officials were used to establish criteria for implementation of a management program:

(a) program for visual condition survey of pavements,
(b) procedure(s) to determine structural deficiencies for critical pavements identified in the visual condition survey, and
(c) utilization of the above information to estimate rehabilitation strategies and their associated costs.

The paper describes and documents three phases of implementation of a pavement and road surface management system. Phase I included development of a system-wide inventory of pavements and a pavement condition rating system for both flexible and rigid pavements. Phase II dealt with the modifications to a microcomputer program to process pavement condition ratings for ranking pavements on the basis of need and also to estimate pavement maintenance and rehabilitation costs. Phase III included administrative and training activities necessary for implementation of the pavement management program. Training generally addressed three areas:

(1) collection of pavement condition and distress information,
(2) operation of the microcomputer program for data processing and analyses, and
(3) interpretation and utilization of results of the analyses.

Finally, the paper describes current research and development relating to refinements and modifications for the Lexington situation.

KEY WORDS: Pavement, Management, Condition Survey, Maintenance and Rehabilitation Strategies, Visual Survey, Implementation

INTRODUCTION AND BACKGROUND

Lexington, located in the central portion of the state, is the second largest city in Kentucky. It is the home of the University of Kentucky, the center for the thoroughbred and standardbred horse industry in Kentucky, and a major center for the marketing of tobacco. Lexington has experienced major growing pains during the past 20 or more years. The influx of light industry combined with the existing agricultural economy has contributed to significant growth.

Lexington is governed by an elected mayor and council of 15 representatives, elected from twelve districts, with three from the community at-large. The administration of streets and roads is the responsibility of the Department of Public Works. The commissioner of Public Works reports to the mayor and council. Technical support and administration of Public Works policies are provided by the Division of Streets and Roads and the Division of Engineering. The Division of Engineering provides technical support in the form of preparation of specifications and designs for construction, reconstruction, resurfacing, and rehabilitation of pavements. The Division of Streets and Roads recommends the annual resurfacing programs.

The street and road network consists of approximately 720 centerline miles. Approximately 100 miles are rural in nature and 620 miles are urban. Approximately 95 percent are bituminous surfaced roads; the majority of the remainder is constructed of portland cement concrete.

Increasing costs for construction and maintenance of streets and roads was a principal stimulus for implementation of a systematic pavement and road surface management system. A number of alternatives for addressing the issue were reviewed. Generally, options were grouped into two categories: (1) a consultant-oriented program and (2) an in-house oriented program. Criteria were established for review of available pavement management systems:

a) The system must include a methodology for visual surveys of pavement condition.
b) The management program should permit implementation of structural evaluations of critical pavement sections identified during the course of visual condition surveys.
c) The system should provide the capability to relate specific pavement distresses to specified maintenance and rehabilitation strategies and their costs and to use this information to estimate costs to repair or rehabilitate each specific section.

In September 1985, the Lexington-Fayette Urban County Government contracted with the University of Kentucky Transportation Research Program for assistance in the implementation of a pavement management system. This paper summarizes activities associated with that implementation process and describes continuing research and refinement of the system.

REVIEW OF PAVEMENT/ROAD SURFACE MANAGEMENT SYSTEMS

Several systems for managing pavements were reviewed (1-5). Procedures utilized by state and federal transportation agencies generally were considered too complex for routine implementation at the local level. Procedures developed for states were typically more oriented toward highvolume, high-fatigue, and high-speed facilities. An example is the pavement management system utilized by the Kentucky Transportation Cabinet (4). In that system, candidate sections for visual condition surveys and nondestructive testing are selected on the basis of ride quality measurements. Interviews with Lexington-Fayette Urban County Government officials revealed that ride quality was not a concern. Therefore, management procedures requiring ride quality as an input were not considered for implementation. High-speed photography and automated pavement condition survey equipment also were investigated. Purchase and maintenance costs of such equipment was prohibitive as was the cost of hiring a consultant or staff for collection and analysis. There also were concerns relative to becoming too dependent upon the expertise and equipment of a consultant such that the pavement management system might fail without that consultant and/or equipment. Thus, greater emphasis was placed on a methodology that could be maintained and supported by in-house staff and resources.

The review indicated two procedures that met all the aforementioned criteria:

(1) A procedure developed by the North Carolina Institute for Transportation Research and Education for that state's Department of Transportation (1) and later modified for use by cities and counties and

(2) The PAVER program developed by the Army Corps of Engineers, Construction Engineering Research Laboratory (5), for the Air Force and later adapted for road and street applications.

The review team generally considered PAVER the more powerful tool. However, there were some handicaps with regard to implementation for the Lexington-Fayette Urban County Government. Government officials favored a microcomputer supported system. At the time of the review, Micro PAVER was in development and was not available (Micro PAVER has since become available in January 1987). Furthermore, there was concern that data collection for PAVER was prohibitive from the perspective of time and manpower requirements. Positive attributes of PAVER included the concrete pavement rating procedure, procedures for detailed economic analysis and budget planning, procedures to predict performance histories, and procedures to store other data such as deflection data from nondestructive testing activities.

The procedure developed by the North Carolina Institute for Transportation Research and Education addressed only flexible (bituminous surface and asphaltic concrete) pavements. The program involved a more cursory pavement condition (distress) survey than PAVER and was based on a total sampling of the street system. The North Carolina procedure was supported by a microcomputer, did permit estimation of maintenance and repair costs for each survey section, and contained a mechanism for maintaining an historical file of pavement conditions. This would permit (external to the system) development of pavement performance curves. The program did not provide a mechanism for incorporation of nondestructive test data into the analysis.

It was decided to modify the North Carolina computer program to fit needs of the Lexington-Fayette Urban County Government.

PAVEMENT CONDITION AND DISTRESS SURVEYS

Interviews with key staff for the Lexington-Fayette Urban County Government were conducted to determine distresses most often observed on streets and roads in Lexington and Fayette County and were delineated as follows:

Asphaltic Concrete Pavements:

1. Alligator Cracking
2. Block/Transverse Cracking
3. Reflective Cracking
4. Rutting
5. Raveling
6. Bleeding
7. Surface Irregularities
   - a. Potholes
   - b. Shoving
   - c. Corrugations
   - d. Joint Deterioration
8. Patching

Portland Cement Concrete Pavements:

1. Blowups
2. Spalling and Popouts
3. Map Cracking, Crazing, Scaling, and Reactive Aggregate Distress
4. Longitudinal Cracking
5. Transverse Cracking
6. Diagonal (Corner) Cracking
7. Joint Deterioration
8. Faulting

Unpaved Roads:

1. Rutting
2. Corrugations
3. Potholes
4. Aggregate Loss (Raveling)
5. Surface Erosion (Deficient Crown)
6. Dust Generation

Distresses are evaluated on the basis of extent and severity. Where appropriate, definitions relating to the extent and severity of distresses for the North Carolina program were used. Where modifications were necessary, definitions of distresses as nearly those presented elsewhere (5, 6) were used. A manual describing pavement conditions and distress ratings was prepared (7).

Selection of different pavement distresses for condition ratings required modifications to the North Carolina computer program. Since approximately 90 percent of the pavement sections in Lexington were constructed of bituminous surface treatments or asphaltic concrete, the University of North Carolina Institute for Transportation Research and Education was contracted to assist in the modification of the initial programs addressing bituminous surface treatments and asphaltic concrete surfaced pavements. Modifications to address concrete pavements and unpaved roads required more time and are now being made by the Kentucky Transportation Research Program.

TRAINING OF PAVEMENT CONDITION SURVEY TEAMS

Repeatability and consistency of condition ratings (from person to person and from time to time) were perceived as a significant factor affecting the success or failure of the pavement management program. To limit the need for additional personnel, Lexington officials proposed to use construction engineering and inspection staff during winter months to perform pavement condition surveys. An initial training program of 3 days was conducted for a group of three construction and design engineers and five engineering technicians. A second training session of 2 1/2 days was conducted a short time later and immediately before beginning the pavement condition survey activities. Initial training activities involved 1/2 day in the office to review definitions for each distress and procedures for completion of data sheets. The remaining time involved field training with pavement condition ratings. Three instructors were used to increase one-to-one contact. The second training program involved additional field training, but utilized only one instructor. The second field training exercise was conducted to demonstrate the repeatability for the various raters.

To evaluate the variability between individual raters, eight streets were selected for comparative analyses. Data for each street were compared to determine the similarity of ratings by various raters. Data for one of these streets are presented in Table 1.

TABLE 1. COMPARISON OF PAVEMENT CONDITION SURVEY INFORMATION BY VARIOUS RATERS

CANTRILL DRIVE: BEGIN AT EASTLAND PARKWAY (EAST), END AT EASTLAND PARKWAY (WEST)
ASPHALT CONCRETE PAVEMENT
LENGTH: 1,090 FT 2 LANES 2 ROLL CURBS

	PERCENT ALLIGATOR CRACKING				OTHER DISTRESSES*							CONDITION
RATER	NONE	SLIGHT	MODERATE	SEVERE	BLK	REF	RUT	RAV	BLD	SIR	PAT	RATING
1	60	30	10	10				L		S	S	40
2	60	10	20	10	L					S		45
3	50	10	20	20				M		S		38
4	40	40	20	0	L							75
5	20	20	40	20				L		M		45
6	50	20	20	10	L					L		63
7	40	20	20	20	L					S		40
8	70	0	10	20				M		M		55
INST1	60	10	10	20	L			M		M		47
INST2	60	20	10	10	L			M		S		42

Average Condition Rating for Raters and Instructors (N = 10): 49.00 ± 11.30
Average Condition Rating for Raters (N = 8): 50.13 ± 12.31
Average Condition Rating for Instructors (N = 2): 44.50 ± 2.50

* BLK — Block Cracking
REF — Reflective Cracking
RUT — Rutting
RAV — Raveling
BLD — Bleeding
SIR — Surface Irregularities
PAT — Patching

L -- Slight
M — Moderate
S -- Severe

SYSTEM-WIDE INVENTORY OF CONDITIONS

The first phase of data collection involved a system-wide inventory to determine length, width, pavement type, and other physical information for each section of pavement to be surveyed. Inventory attributes are summarized below:

(1) Date of Survey - Month, year
(2) Street Name
(3) Class of Street - Residential, collector, or arterial
(4) Beginning Description - Street name or other physical feature

(5) Ending Description - Street name or other physical feature
(6) Pavement Type - Bituminous surface treatment, asphaltic concrete, portland cement concrete, or unpaved roads
(7) Length
(8) Width of Street
(9) Number of Lanes
(10 Width of Shoulder
(11) Number of Curbs - One side only; both sides of street
(12) Type of Curbs

Office files were reviewed to determine available information. Inventory information was obtained on a block-by-block basis for urban streets and for a 1,000-foot section for rural roads. Street names, classifications of streets, and beginning and ending descriptions were typically obtained from office files and maps. Other inventory information were obtained in the field.

Two members of the survey team were assigned the task of collecting all inventory data for the entire city. The city was subdivided into twelve survey districts corresponding to the twelve council districts. Once inventory data were obtained for three survey areas, three survey teams collected pavement condition information while the fourth team continued to collect inventory information. The fourth team assisted in the collection of pavement condition information upon completion of the inventory.

MICROCOMPUTER PROGRAM

A microcomputer program developed by the University of North Carolina Institute for Transportation Research and Education was modified for implementation in Lexington. The microcomputer program is supported by dBASE III PLUS data management software. The programs are compiled for greater processing speed.

The computer program was modified to account for pavement distress categories for flexible pavements as previously listed. Pavement distress categories for rigid (portland cement concrete) and unpaved roads currently are being developed and programmed.

The microcomputer program is a tool that permits the user to generate the following types of reports:

1. Summary of Inventory Data
2. Report Forms for Collection of Distress Data
3. Summary of Inventory and Distress Data
    a) In the order as recorded
    b) Alphabetized by street/road name
4. Summary Reports
    a) Information included -- pavement condition ratings, repair strategies, total costs of repairs, cost of patching, and cost to repair a 1-mile section
    b) Alphabetical Listing by Street/Road Name
    c) Listing of Survey Data by Priority (Serviceability Rating)
    d) Maintenance Needs Summary by Street Classification
    e) Summary of Maintenance and Repair Costs and Condition Ratings

by Street Classification

The above reports are features already existing with the initial software. Additionally, Lexington officials requested sufficient flexibility to generate reports for any combinations of the data set. For example, a field was to be designated for a condition rating for curbs or shoulders, for the number of manholes within a survey section, and for the number of utility cuts within a section. This information is not used to compute pavement condition ratings but was considered useful by city officials. A report generation routine was developed to permit the combination of any portion of the data set in any desired format. The above reports may be developed for the entire city or for individual survey areas or combinations thereof.

The microcomputer program may be used to compute a pavement serviceability rating (PSR) for each street section. The PSR is a function of the extent of the observed distress (percent of the area or length, as appropriate) and a series of deduct points assigned for each level of severity for the various distresses. Maximum deduct points are determined on the basis of experience (5) and judgment for each general location and class of street. Care should be exercised when selecting maximum deduct points for the various distresses and classes of streets. The program as implemented does provide the user with this flexibility. However, changes in deduct values will require recalculation for all previous data to create a valid historical record of changing pavement condition ratings. Deduct points used for Lexington are summarized in Table 2.

TABLE 2. MAXIMUM DEDUCT POINTS

	LEVEL OF SEVERITY			
TYPE OF DISTRESS	NONE	SLIGHT	MODERATE	SEVERE
Alligator Cracking	0	25	50	75
Block Cracking	0	5	15	25
Reflective Cracking	0	5	15	25
Rutting	0	5	15	25
Raveling	0	0	5	10
Bleeding	0	5	7	10
Surface Irregularities	0	5	15	25
Patching	0	0	5	10

Specific maintenance and/or repair strategies are related to observed distresses. Maintenance and repair strategies may vary, dependent upon the specific class of street. Repair strategies used for Lexington are summarized in Table 3. Unit costs for the various repair strategies are required to determine repair costs for each maintenance and repair alternative. The user may modify these unit costs as material and construction costs change.

The user is required to input information used to determine a resurfacing criterion when percentages of the pavement area with alligator cracking, patching, and/or partial overlay exceed selected limiting values. These cutoff values used for Lexington are summarized in Table 4. Table 4 also

TABLE 3. REPAIR STRATEGIES

TYPE OF DISTRESS	CLASS OF STREET*	LEVEL OF SEVERITY			
		NONE	SLIGHT	MODERATE	SEVERE
Alligator Cracking	A	No Repair	Skin Patch	Full-Depth Patch	Full-Depth Patch
	B	No Repair	Skin Patch	Full-Depth Patch	Full-Depth Patch
	C	No Repair	Skin Patch	Full-Depth Patch	Full-Depth Patch Mill 1.0" AC
Block Cracking	A	No Repair	Seal Cracks	Seal, 1" Overlay	1.5" Overlay
	B	No Repair	Seal, 1" Overlay	2.0" Overlay	2.0" Overlay
	C	No Repair	Seal, 1" Overlay	2.0" Overlay	3.0" Overlay
Reflective Cracking	A	No Repair	Seal Cracks	Seal Cracks	Joint Repair
	B	No Repair	Seal Cracks	Joint Repair	Joint Repair Mill 2.0" AC
	C	No Repair	Seal Cracks	Joint Repair	Overlay 2.5" AC Mill 1.0" AC
Rutting	A	No Repair	No Repair	1.0" AC Overlay Mill 1.0" AC	1.5" AC Overlay Mill 2.0" AC
	B	No Repair	1.0" AC Overlay	1.5" AC Overlay Mill 1.0" AC	2.5" AC Overlay Mill 2.0" AC
	C	No Repair	1.0" AC Overlay	1.5" AC Overlay	2.5" AC Overlay
Raveling	A	No Repair	No Repair	1.0" AC Overlay	Seal, 1.0" AC Overlay
	B	No Repair	No Repair	1.0" AC Overlay	2.0" AC Overlay
	C	No Repair	No Repair	1.0" AC Overlay	2.0" AC Overlay
Bleeding	A	No Repair	No Repair	No Repair	1.0" AC Overlay
	B	No Repair	No Repair	No Repair	1.0" AC Overlay
	C	No Repair	No Repair	No Repair	1.0" AC Overlay
Surface Irregularity	A	No Repair	Skin Patch	Skin Patch	Full-Depth Patch
	B	No Repair	Skin Patch	Skin Patch	Full-Depth Patch
	C	No Repair	Skin Patch	1.0" AC Overlay	2.0" AC Overlay
Patching	A	No Repair	No Repair	No Repair	Short Overlay
	B	No Repair	No Repair	1.0" AC Overlay	2.0" AC Overlay
	C	No Repair	No Repair	1.0" AC Overlay	2.0" AC Overlay

* A — Residential Street
B — Collector Street
C — Arterial Street

presents assumed widths of patching to be used when full-depth and skin patching is required as a maintenance and repair strategy.

Interviews with Lexington officials revealed a consensus of the minimum resurfacing requirements for each class of street. For residential streets, the minimum resurfacing should be 1.0 inch of asphaltic concrete and, for collector streets, 2.0 inches of asphaltic concrete when no or only slight rutting exists and the percentages of alligator cracking and patching exceed specified limiting valves. Structural evaluation by deflection testing or other methods was considered necessary when rutting was moderate or severe and

TABLE 4. LIMITING VALUES FOR RESURFACING AND ASSUMED WIDTHS OF PATCHING

	CLASS OF STREET		
	RESIDENTIAL	COLLECTOR	ARTERIAL
Cutoff for Alligator Cracking	50%	40%	30%
Cutoff for Overlay	50%	40%	30%
Assumed Width for Full-Depth Patch	4 ft	6 ft	12 ft
Assumed Width for Skin Patch	4 ft	6 ft	12 ft

the limiting valves were exceeded. Structural evaluations were considered necessary for all arterial streets where the percentages of alligator cracking and patching exceeded the limiting valves.

The costs for maintenance or repairs for each survey section are estimated. Summary calculations are made to estimate the total costs for maintenance and repair of each section, the total cost to repair a 1-mile section, and the cost for full-depth patching repairs. Information for each survey section may be summarized for the entire city and/or each street classification.

SUMMARY AND CONCLUSIONS

It might be opined that government officials or public administrators are not to save money; they are instead to utilize available funds more effectively and efficiently. Thus, the needs and benefits of pavement management are presented. The following are benefits perceived by Lexington-Fayette Urban County staff responsible for managing streets and roads:

(1) Pavement management is a tool that may provide factual support for the decisions of elected officials and assist them in fulfilling their obligations to the public to allocate available funding to the more worthy and cost-effective projects. Pavement management is a tool that provides data to demonstrate to the constituents how "their" streets compare with others in the city.

(2) Pavement management provides city engineers with data to evaluate the change in pavement performance with time. For example, is the number of miles of streets in a given category or level of serviceability (good, fair, poor, failed, etc.) increasing or decreasing? Such information is useful in evaluating the success of specific maintenance and/or repair strategies and the adequacy of funding levels.

(3) Pavement management provides the opportunity to be innovative. City officials may play "What if? games" to assess the expected impact of budget changes, alternative rehabilitation strategies, etc.

The above expectations are somewhat idealistic. All benefits have not yet been fully realized in Lexington. The degree of acceptance among elected officials and career staff remains mixed. For example, the 1987 resurfacing program was developed from two viewpoints. Eighty percent of the resurfacing budget was allocated on the basis of the pavement management system. Of this eighty percent, half the streets were selected from the those having condition rankings between 40 and 50. The remaining half were selected from pavement sections having condition ratings less than 30. This strategy directed approximately half of the funds to those pavements in the fair to poor categories where resurfacing or major maintenance would be expected to derive the greatest benefits. The remaining funds were allocated to those sections in the very poor or failed category where benefits of resurfacing might be less well defined. The remaining twenty percent of the budget was allocated to projects at the discretion of the city-county council members. The willingness of elected officials to permit allocation of eighty percent of the resurfacing funds on the basis of the pavement management study was encouraging. In time, as administrators become more accustomed to the system, this percentage is expected to increase. Additionally, technical staff are expected to make greater use of the pavement management data set to optimize the expenditure of available funds.

Continuing development efforts have identified the distresses that will be used to rate rigid pavements and unpaved roads. Deduct points associated with each distress and appropraite for the Lexington environment are to be defined. A study is currently underway to apply principles of dynamic programming to select various strategies in a manner to maximize expected benefits.

Finally, implementation of a pavement management program probably could benefit any local government. The degree of sophistication may be dependent upon the resources and needs of the specific jurisdiction. It is possible to benefit from the work of others, but the system should be customized to each locality. The use of an in-house system versus a consultant managed system is dependent upon resources of the community. Key local government staff should be involved regardless of who develops and/or maintains the pavement management program. The program may flounder if there are personnel changes that shift experienced personnel to other responsibilities. Therefore, designation of a "pavement management staff" is important but not imperative to the long-term success of the program. The greater the commitment, the greater the success and potential benefits.

The bottom line is not whether cities need and should implement a pavement management program. Instead, can local governments afford not to utilize a pavement management program? A pavement management program can (and should) be structured to meet specific needs and resources (both manpower and financial) of the jurisdiction. Whenever feasible, the work of others should be utilized. The important issue is to get started; implementation of a pavement management system may be by stages. Refinements and modifications will come with experience.

REFERENCES

1. "Pavement Management System: Vol 1, Pavement Condition Survey," Institute for Transportation Research and Education, University of North Carolina, Research Triangle Park, North Carolina, Februrary 1982.

2. "Road Surface Management for Local Governments," US Department of Transportation, Federal Highway Administration, Washington, DC, May 1985.

3. "Implementing Pavement Management Systems, Do's and Dont's at the County/City Level," W. Wells, M. Y. Shahin, R. E. Smith, and M. I. Darter, Proceedings, North American Pavement Management Conference, Vol 2, Toronto, Ontario, Canada, March 1985.

4. "Pavement Management in Kentucky," G. W. Sharpe, R. C. Deen, H. F. Southgate, R. L. Rizenbergs, and J. L. Burchett, Proceedings, North American Pavement Management Conference, Vol 2, Toronto, Ontario, Canada, March 1985.

5. "Pavement Maintenance and Management for Roads and Parking Lots," M. Y. Shahin and S. D. Kohn, Technical Report M-294, Construction Engineering Research Laboratory, US Army Corps of Engineers, Champaign, Illinois, October 1981.

6. "Highway Pavement Distress Identification Manual for Highway Condition and Quality of Highway Construction Survey," US Department of Transportation, Federal Highway Administration, Washington, DC, March 1979.

7. "User's Guide for Pavement Condition Surveys," G. W. Sharpe, H. F. Southgate, and R. C. Deen, University of Kentucky Transportation Research Program, Research Report UKTRP- 87-12, June 1987.

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ASPHALT CONCRETE PAVEMENT
LENGTH: 1,090 FT   2 LANES   2 ROLL CURBS

	PERCENT ALLIGATOR CRACKING				OTHER DISTRESSES*							CONDITION
RATER	NONE	SLIGHT	MODERATE	SEVERE	BLK	REF	RUT	RAV	BLD	SIR	PAT	RATING
1	60	30	10	10				L		S	S	40
2	60	10	20	10	L					S		45
3	50	10	20	20				M		S		38
4	40	40	20	0	L							75
5	20	20	40	20				L		M		45
6	50	20	20	10	L					L		63
7	40	20	20	20	L					S		40
8	70	0	10	20				M		M		55
INST1	60	10	10	20	L			M		M		47
INST2	60	20	10	10	L			M		S		42

Average Condition Rating for Raters and Instructors (N = 10): 49.00 $\pm$ 11.30
Average Condition Rating for Raters (N = 8): 50.13 $\pm$ 12.31
Average Condition Rating for Instructors (N = 2): 44.50 $\pm$ 2.50

* BLK -- Block Cracking
REF -- Reflective Cracking
RUT -- Rutting
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BLD -- Bleeding
SIR -- Surface Irregularities
PAT -- Patching

L -- Slight
M -- Moderate
S -- Severe

TABLE 3. REPAIR STRATEGIES

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	C	No Repair	Skin Patch	Full-Depth Patch	Full-Depth Patch Mill 1.0" AC
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	B	No Repair	Seal, 1" Overlay	2.0" Overlay	2.0" Overlay
	C	No Repair	Seal, 1" Overlay	2.0" Overlay	3.0" Overlay
Reflective Cracking	A	No Repair	Seal Cracks	Seal Cracks	Joint Repair
	B	No Repair	Seal Cracks	Joint Repair	Joint Repair Mill 2.0" AC
	C	No Repair	Seal Cracks	Joint Repair	Overlay 2.5" AC Mill 1.0" AC
Rutting	A	No Repair	No Repair	1.0" AC Overlay Mill 1.0" AC	1.5" AC Overlay Mill 2.0" AC
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	C	No Repair	Skin Patch	1.0" AC Overlay	2.0" AC Overlay
Patching	A	No Repair	No Repair	No Repair	Short Overlay
	B	No Repair	No Repair	1.0" AC Overlay	2.0" AC Overlay
	C	No Repair	No Repair	1.0" AC Overlay	2.0" AC Overlay

* A — Residential Street
B — Collector Street
C — Arterial Street

TABLE 4. MAINTENANCE AND REPAIR COSTS

REPAIR ITEM	UNIT COSTS FOR REPAIRS
Crack Pouring	$194/ft of width/mile
Joint Patching	$375/ft of width/mile
Skin Patching	$19,360/12-ft lane mile; (1" thick)
Full-Depth Patching	$116,160/12-ft lanemile; (6" thick)
Short Overlays	$1,320/ft of width/mile
Seal	$406/ft of width/mile
1.0" AC Overlay	$1,400/ft of width/mile
Mill 1.0" AC, Overlay 1.5" AC	$2,681/ft of width/mile
2.0" AC Overlay	$2,800/ft of width/mile
Mill 2.0" AC, Overlay 2.5" AC	$4,662/ft of width/mile
3.0" AC Overlay	$4,200/ft of width/mile
Structural Overlay	$5,600/ft of width/mile
Seal Plus 1.0" AC Overlay	$1,806/ft of width/mile