Distress Collection for the City of Philadelphia with an Emphasis on Assessing the Impact of Utility Patching on the Network

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ABSTRACT

The City of Philadelphia's Department of Streets is responsible for the preservation of over 2,000 miles of City streets, including 280 blocks of historic streets. Over the past several years, the City has relied on its Highway Districts and Department of Streets staff to cost-effectively manage the City's investment in this asset.

The City is currently encountering the same operational issues that many large cities are facing. Based upon 2000 census reports, the City is projecting a 32% decrease in its Capital Street Resurfacing budget by fiscal year 2008 due to a reduction in the urban population. In addition, utility patching is a major concern for streets in Philadelphia. The combination of an aging utility infrastructure and new work from the telecommunications industry result in an estimated 20,000 penetrations into the City's streets for utility work each year.

At this time, the City is implementing a pilot pavement management system for its 5th Highway District. The purpose of the pilot implementation is to assess pavement management as a tool for supporting planning and budgeting activities. The pavement management system will not only aid in determining the best use of available funding but will also be interfaced with the Department's Guaranteed Paving Information System (GPIS) which will be used to coordinate utility cuts with scheduled street maintenance and reconstruction activities.

This paper focuses on the creation and use of a computerized distress collection form to enter the necessary information for the pavement management system implementation. Further discussion provides information on the data collection process and production rate. The surveys also focused on the collection of information to quantify the impacts of utility cuts on the street network in Philadelphia.

Six condition indices were computed from the distress survey data: overall condition, patching, structural, environmental, rutting and distortion, and joint deterioration. To quantify the impact of utility cuts, treatment trigger values were selected for these indices in order to determining sections requiring overlays. Based on 2001 survey data the analysis showed that 16.5% of the area requiring overlays was triggered solely due to utility patching.

INTRODUCTION

The City of Philadelphia's Department of Streets is responsible for the preservation of over 2,000 miles of City streets, including 280 blocks of historic streets some of which have streetcar tracks that must be preserved. In the past, the City has relied on its Highway Districts and Department of Streets staff to cost-effectively manage the City's investment in this asset.

As this network has aged, the challenge of maintaining the existing pavements has greatly increased due to budget changes. For instance the entire maintenance budget for Street activities was $19 million in 2002, with approximately $14 million being allocated to capital improvements. The City also receives approximately $10 million per year in Federal Aid. The capital budget has been sufficient for resurfacing approximately 2.7 to 2.9 million square yards of pavement each year. However, based on the results of the 2000 census figures, the City is projecting a 32% decrease in its Capital Street Resurfacing budget by fiscal year 2008 due to a decrease in the City's population.

Utility patching is also a major concern for Philadelphia's street network. There are an estimated 20,000 annual penetrations into the City streets for utility work. The City is presently implementing a system to coordinate utility cuts with scheduled street maintenance activities, but the increased maintenance requirements to support the utility operations in the City have placed an additional burden on the City's maintenance staff and budget.

The City of Philadelphia is not unique in terms of the challenges it is facing. It is taking proactive steps towards the implementation of tools that will help the Department of Streets provide the best possible pavement conditions under these demanding circumstances. For example, the City has started using preventive maintenance techniques such as hot in-place recycling, Novachip®, and microsurfacing as part of its preservation program. The City is also implementing a pavement management system to enhance the effectiveness of their program. The City of Philadelphia has been involved in the first phase of a pilot pavement management implementation since early 2001. The first phase of the project has been completed. It included an assessment of the City's pavement management needs and the collection of data to support the pavement management analysis of the pilot implementation for the City's 5^{th} Highway District.

The City of Philadelphia decided to create two types of repair units at the section level, city blocks and intersections. City blocks average only 500 feet in length and 30 feet in width. Intersections average approximately 100 square yards. Intersections were identified as separate units to prevent double counting of the square yardage and to allow the paving engineers the flexibility to add or delete them from the City's work plans as warranted.

The Department's Information and Technology staff created the repair units. The City maintains a GIS TIGER centerline file, which houses a citywide compendium of street codes, address ranges, street segment identifiers called BD#'s, and the accurate spelling and directional prefixes of all street names. A program was written that assigned a unique identifier called a PV_ID to individual address ranges. Each address range corresponds to a City block. When fully implemented for the entire City, the database will contain 44,000 repair units consisting of 20,000 city blocks and 24,000 intersections.

These abbreviated section lengths were necessary because at the branch level the maintenance history of the City's streets is disjointed. This patchwork is due to the intermittent original construction history of the branch itself, the varying ages of the underground utility infrastructure, and sporadic political service requests. These constraints restrict the district paving engineers to programming maintenance of not more than two or three contiguous city blocks of the same branch. However, utilizing a GIS-based pavement management system, paving engineers will be able to view color-coded maintenance histories and surface conditions of the repair units within branches and consolidate them to gain economies of scale. Ultimately, the Department's engineers intend to rely heavily on the pavement management system to present to city council an organized, efficient, cost-effective strategic maintenance program.

This paper focuses on the methods used to collect the condition data needed for the City of Philadelphia's pilot pavement management system. Some background information is presented in order to explain the selection of the given data collection method. Sample survey forms are shown to illustrate the utilized survey procedure. An explanation of how those survey forms were developed into an automated data collection method is also discussed. Screen shots illustrate the user interface of the automated data collection method. Details of production rates and how the collected data was used to assess the extent of utility cut impact to the 5^{th} Highway District network are also given.

PAVEMENT CONDITION ASSESSMENT

Overview

There are many methods available for assessing the functional and structural condition of pavements. The method of condition assessment used is typically a function of an agency's needs and available resources. Condition assessment may include visual inspections, friction testing, roughness testing, testing with a ground penetrating radar, structural testing using a falling weight deflectometer, and destructive testing using cores or other methods. This study, however, concentrated on the evaluation of pavement condition solely by conducting visual inspections.

Visual condition surveys (or distress surveys) vary from the simplistic to extremely detailed and complex. On the simple end of the scale, some agencies use a windshield survey where raters drive along the shoulder of the road and rate the pavement on a scale of 0 to 10 based upon the surface distresses given. No notation of the types or extents of distresses are noted. The obvious shortcoming with this method is that when rehabilitations are recommended, the analyst has no method of determining what types of distresses influenced the overall rating. The analyst only knows that the road is in a certain condition state.

On the complex end of the scale is the Pavement Condition Index (PCI) survey. The PCI was developed to provide engineers with a numerical indication of overall pavement condition. During a PCI survey, visible signs of deterioration within a selected sample unit are measured, recorded, and analyzed. Distress type, severity, and quantity are all identified and recorded. The final calculated PCI value is a number from 0 to 100, with 100 representing a pavement in excellent condition, as shown in figure 1.

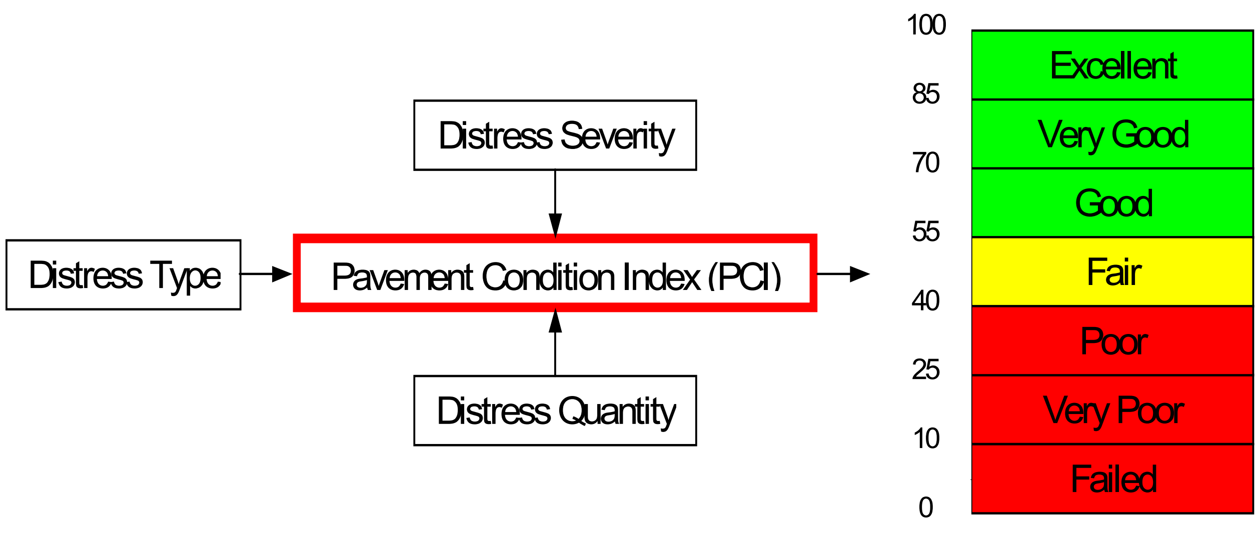


Figure 1. PCI rating scale.

Subjective condition surveys have been conducted in Philadelphia in the past, but the surveys are no longer used due to staffing issues and the subjectivity of the process. Today, pavement preservation activities are determined based on a three-year program of needs developed by each District Engineer. These lists are then combined and the Construction Engineer establishes priorities. Resurfacing is generally divided equally between the Districts. Considerations are made for political concerns and utility plans are also considered in the development of the final three-year program. Pavement maintenance and rehabilitation decisions are often influenced by the geographic location of the streets needing resurfacing to facilitate the clustering of projects for cost efficiencies. Conventional resurfacing is done by City forces, although milling is typically contracted out. Also contracted out exclusively is street reconstruction, which is usually done only in conjunction with major water and sewer main replacement.

Assessment Method for the City of Philadelphia

Based upon the resources of the City and the intended use of the pavement management system, an approach in the middle of the two survey procedures previously described was recommended for the City of Philadelphia. The proposed rating method required more detail than a simple windshield numeric rating but was much less labor intensive than a true PCI rating. Additional time was saved as quantities were estimated instead of directly measured. The basic components of the system are outlined on the simplified rating sheets for hot-mix asphalt (HMA), portland cement concrete (PCC), and other pavement types such as brick, granite block or cobblestone are shown in figures 2, 3, and 4, respectively. These sheets are used by the field crew to rate each block and intersection of pavement. In this section, the details of the survey sheets are explained along with the basic steps of the rating procedure. The details of the step-by-step procedure used for conducting the surveys are explained in a following section.

The approach includes an estimate of severity and extent of each distress by the rater. Rating of the pavement sections can be completed from the vehicle or the sidewalk area. After driving or walking the entire length of the section, the rater determines the predominant severity of each distress present and then estimates the total area for that distress in the pavement section. The estimates are based upon a 100% sample rate of the pavement.

The rating for HMA pavement concentrates on seven types of distresses. The rating for PCC and other streets concentrate on six types of distresses for each. For each distress of HMA and PCC pavement types, three severity levels and three extent categories are used for quantifying the significance of pavement distress. The severity levels (low, medium, and high) correspond to significance of the distress such as crack width, measurement of faulting, etc. Regarding distress extent, the low, medium, and high categories correspond to 1-10%, 11-30%, and 31+%, respectively. With distress severity and extent noted, four distress indices are then computed along with an overall pavement index for the HMA pavement. For PCC pavements, three distress indices and an overall pavement index are computed.

The rating procedure of other pavement surface types is slightly different. Streets with unconventional surfaces such as brick, granite block, and cobblestone, have six distress types rated on a good/fair/poor scale. The pavements are categorized into good, fair, or poor condition according to the scale shown in figure 4. With all six conditions evaluated an overall index is estimated. Additional details of the rating method are discussed in the following sections.

City of Philadelphia Pavement Management System

Flexible Pavement Condition Survey

Street: ______________________________

Block: ______________________________

Section No.: ______________________________

From: ______________________________

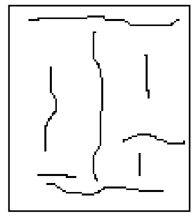
To: ______________________________

Length: ___________ Width:__________

No. Lanes: ______________________________

Surface Type: HMA HMA/PCC Surf. Treat
(circle one) HMA/Brick HMA/Granite Block
Other:_________________________

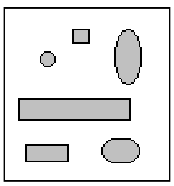
C Longitudinal/Transverse Cracking



NONE: 100

Severity	Low 1-10%	Med 11-30%	High 31+%
Low	90	77	72
Med	78	60	55
High	56	20	14

A Patching/Potholes Utility Cuts



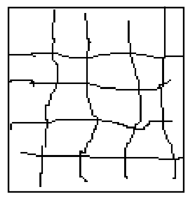
NONE: 100

Severity	Low 1-10%	Med 11-30%	High 31+%
Low	90	77	66
Med	78	58	42
High	63	32	20

No. of potholes _____

Patch Type AC PCC

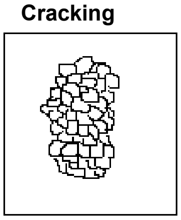
D Block Cracking



NONE: 100

Severity	Low 1-10%	Med 11-30%	High 31+%
Low	96	88	80
Med	90	78	67
High	80	60	42

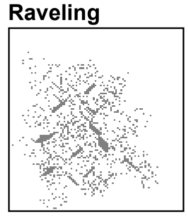
B Alligator Cracking



NONE: 100

Severity	Low 1-10%	Med 11-30%	High 31+%
Low	75	60	48
Med	62	45	33
High	47	30	18

E Weathering/ Raveling



NONE: 100

Severity	Low 1-10%	Med 11-30%	High 31+%
Low	97	92	88
Med	95	89	77
High	91	83	68

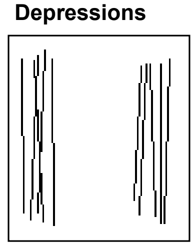
F Transverse Distortions

Check Road for Presence of the Following:
- Uneven Surface
- Corrugation
- Sags
- Humps
- Frost Heaves

NONE: 100

Severity	Low 1-10%	Med 11-30%	High 31+%
Low	92	80	69
Med	68	51	38
High	48	28	15

G Rutting/ Depressions



NONE: 100

Severity	Low 1-10%	Med 11-30%	High 31+%
Low	79	65	54
Med	65	46	37
High	52	27	15

Utility Patching Index (Value from **A**): ______________

Structural Index (Value from **B**): ______________

Environmental Index (Smallest of **C**, **D** & **E**): ______________

Rutting & Distortion Index (Smallest of **F** & **G**): ______________

Figure 2. Distress rating sheet for HMA pavements for pilot implementation.

City of Philadelphia Pavement Management System

Rigid Pavement Condition Survey

Street: ____________________

Block: ____________________

Section No: ____________________

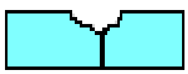
From: ____________________ To: ____________________

Length: ____________________ Width: ____________________

Slab Width: ____________________ No. Lanes: ____________________

Slab Length: ____________________

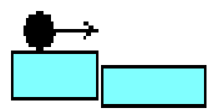
A Joint Spalling



NONE: 100

Severity	Extent * Low 1-10%	Med 11-30%	High 31+%
Low	99	94	90
Med	95	92	82
High	90	76	58

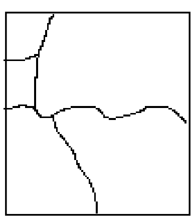
B Faulting



NONE: 100

Severity	Extent * Low 1-10%	Med 11-30%	High 31+%
Low	99	94	77
Med	96	85	60
High	93	70	40

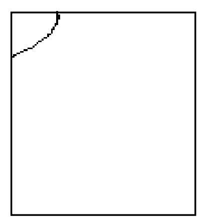
C Divided Slabs (4 or more pieces)



NONE: 100

Severity	Extent * Low 1-10%	Med 11-30%	High 31+%
Low	95	80	62
Med	89	65	43
High	84	50	25

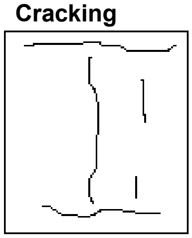
D Corner Break



NONE: 100

Severity	Extent * Low 1-10%	Med 11-30%	High 31+%
Low	95	82	65
Med	92	72	47
High	89	60	33

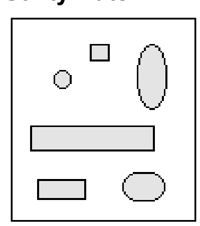
E Longitudinal and Transverse Cracking



100

Severity	Extent * Low 1-10%	Med 11-30%	High 31+%
Low	97	90	80
Med	95	86	73
High	90	70	55

F Patching/Potholes Utility Cuts



NONE: 100

Severity	Extent * Low 1-10%	Med 11-30%	High 31+%
Low	98	94	82
Med	96	88	66
High	90	70	48

Joint Condition Index (Smaller of A or B): ____________________

Structural Index (Smallest of C, D, or E): ____________________

Utility Patching Index (Value from F): ____________________

* Extent is based on the number of slabs except for faulting where it is the number of joints

Figure 3. Distress rating sheet for PCC pavements for pilot implementation.

City of Philadelphia Pavement Management System

Other Paved Condition Survey

Street: ______________________________

Block: ______________________________

Section No: ______________________________

From: ______________ To: ______________

Length: ______________ Width: ______________

______________ No. Lanes: ______________

Pavement Conditions	Good	Fair	Poor
Corrugations			
Potholes			
Rutting			
Improper Cross-Section			
Roadside Drainage			
Loose Aggregate			

Score	Rating
100	
	Excellent
90	
80	Very Good
70	
	Good
60	
50	Fair
40	
	Poor
30	
20	Very Poor
10	
0	Failed

Overall Condition Score: ______________________

Guidelines

Excellent (85-100)	All pavement conditions marked good
Very Good (70-85)	Predominantly good markings with no more than one fair and no poor
Good (55-70)	Predominantly good markings with no more than two fair or one poor
Fair (40-55)	No more than two good nor two poor items marked
Poor (25-40)	Predominantly poor markings with at least two items marked fair or good
Very Poor (10-25)	Predominantly poor markings with at least one item marked fair or good
Failed (0-10)	All items marked poor

Figure 4. Distress rating sheet for unpaved (cobblestone) streets for pilot.

Distresses Included in Rating System

Distresses used in the rating system were chosen based on predominate distress types identified by the City of Philadelphia personnel, as well as, a review of other pavement management systems used by public agencies around the United States.

HMA Pavements

The City of Philadelphia was most concerned with the impact of utility cuts and environmental cracking on the performance of its streets. With these distresses serving as the basis for the rating system, a total of seven distress types were included in the HMA rating system:

- Alligator cracking.
- Patching, potholes, and utility cuts.
- Longitudinal/transverse cracking.
- Block cracking.
- Weathering/raveling.
- Transverse distortions.
- Rutting/depressions.

Alligator cracking was chosen to represent structural distress that may be developing or present in a pavement. Utility cuts and other patching create a significant effect on driver comfort and the performance of the pavement. Pothole data was collected with utility cuts and patching; however, potholes along with alligator cracking were used to represent structural distress.

Transverse distortions affect the ride of vehicles using the roadway. Typically, in urban settings this type of distress is found in the area of intersections where the braking action of vehicles has created corrugations in the pavement. Longitudinal grade can also add to the development of transverse distortions. Rutting and depressions affect ride as well as safety as they can lead to hydroplaning and also make removal of snow and ice difficult.

Longitudinal, transverse, and block cracking were included as significant distresses based upon the development of these distresses due to environmental and material causes. Longitudinal cracking can be an early indicator of alligator cracking as well. Weathering and raveling are also environmental- and material-related distresses.

Using a scale of 100 (no distress) to 0 (failed), deduct points were determined from the Metropolitan Transportation Commission (MTC) pavement condition survey procedures except for weathering and raveling. The MTC approach was originally based on the PCI method developed by the Corps of Engineers (Shahin and Kohn 1981). The weathering and raveling scores being utilized were developed by the Georgia Department of Transportation (FHWA 2000). This change was adopted since many practitioners believe the deduct points assigned to weathering and raveling in the PCI method are too severe for the distress.

PCC Pavements

For PCC pavements the distresses selected for rating include:

- Joint spalling.
- Faulting.
- Divided slabs.
- Corner breaks.
- Longitudinal and transverse cracking.
- Patching and utility cuts.

Joint spalling and faulting provide an indication of the condition of the joints of the pavement. Both distresses were selected for inclusion in the condition ratings because they affect the ride of the pavement. The distress types of divided slabs, corner breaks, and longitudinal and transverse cracking were included in the rating system to represent the structural distress that may be developing or present in a pavement. As in asphalt pavements, patching and utility cuts were included as they increase pavement roughness and affect driver comfort, while also leading to further deterioration in the surrounding slab.

Deducts for each of these distresses are based upon the PCI method described in ASTM D6433-99 (ASTM 1999). The rating is based upon a scale of 100 (no distress) to 0 (failed).

Other Pavement Types

As shown in figure 4, the distresses selected for rating other pavement types include:

- Corrugations.
- Potholes.
- Rutting.
- Improper cross-section.
- Roadside drainage.
- Loose aggregate

These six items were first rated individually as good, fair, or poor. Next, an overall condition rating was estimated for the roadway based upon the same scale used for HMA and PCC pavements. The individual indices were estimated based upon the numeric scale shown in figure 4. Guidelines for the overall index are provided on the rating sheet based on the rating given to each of the individual distresses.

RATING METHOD PROCEDURE

As with any procedure, outlined steps must be developed to provide a repeatable method. For the rating procedure used in Philly, eight steps were created. The following rules are to be applied when performing ratings:

1. All distress extents are based on the full width of the pavement travel way. Parking areas were included in the distress rating while shoulders are not rated. This is used to keep shoulder areas that may be in relatively good condition from masking other distress types.

2. The rater should walk or drive the length of the section before rating it.

3. The rater should then determine which of the seven distress types for HMA pavements and six distress types for PCC and other pavement types are present and the predominant severity level of each noted distress.

4. The predominant severity should be determined based upon which severity level has the greatest quantity. For example, assume all three levels of alligator cracking are present in the following quantities; low severity – 5%, medium severity – 10%, and high severity – 1%. The predominant distress severity is then medium level. To determine the extent, the total of all three severity levels is totaled to 16%.

5. The rater will estimate extent of a distress based on visual observation. The rater will not be required to make detailed measurements of distresses.

    a. All cracks are assumed to be at least one foot wide for the purpose of determining area of distress.

    b. Extent of transverse distresses can be estimated by estimating the spacing of the cracks and dividing it into 1 as shown in equation 1.

$$\%\ transverse\ cracking = \frac{1}{transverse\ crack\ spacing} * 100\% \qquad (1)$$

    c. Extent of longitudinal cracking that extends for the full length of a block may be estimated using the formula shown below.

$$\%\ longitudinal\ cracking = \frac{number\ of\ longitudinal\ cracks}{street\ width} * 100\% \qquad (2)$$

    d. Extent of PCC distresses is based upon the number of slabs or joints that exhibit the distress.

6. The rater then marks the appropriate box on the rating sheet for that distress. The box marked reflects the condition index for that particular distress.

7. When rating pavements that do not have HMA or PCC surface, the rating method as shown in figure 4 is utilized. All six distress types are rated at good, fair or poor which corresponds to the scale presented in figure 4.

8. After the appropriate boxes are marked for the applicable distress types, the distress information is combined into indices as indicated at the bottom of the rating sheet.

By following these eight steps, the survey provides a repeatable and reliable method for assessing the condition of the pavement sections. The advantage of this simplified pavement condition method is that it is quick and relatively simple. Training of personnel to perform the rating was accomplished through the distribution of manuals and a few hours of practice in the field with an experienced pavement engineer. The use of a two-person crew provided the opportunity for discussion between the crew members especially when distresses manifested in unusual manners. A two-person crew also provides two sets of eyes to help locate the hard to notice distresses along with providing a more thorough coverage of the pavement area. The disadvantage of this system is that quantities are estimated so some subjectivity is possible.

Computerized Rating Form

In order to expedite the data collection process, a decision was made to automate the field survey sheets. The survey sheets shown in figures 2, 3, and 4 were modified into visual basic user forms, which were linked to an Excel spreadsheet. The computerized rating form has two basic user interfaces. The first interface is the actual spreadsheet that lists the 5th Highway District sections in alphabetic order according to the street name. The second interface is the user form that allows the input of condition information for a selected section.

Initial inventory information was stored in the spreadsheet. This information included the street name with corresponding "To-From" designations, length and width, street code numbers, GIS link values, and last resurfacing date. This data provided the basic information required to locate and conduct the survey while allowing field verification of important inventory data.

Survey Form Use

The Excel spreadsheet allows sections to be selected and surveyed using the visual basic form for easy data entry. The condition data recorded on the user form is then stored in the appropriate location in the spreadsheet. The details for using the computerized form are outlined in the following steps:

1. With the spreadsheet form open, the section that is to be rated is selected by highlighting a portion of the line on which it occurs. The sections were organized alphabetically by street name to allow for quick retrieval of a section to be surveyed. As shown in figure 5, 2nd Street between Westmoreland Street and Ontario Street was the street section to be surveyed.

2. With the desired section selected, the cursor is moved to column A. The user form for input of the condition of the section is retrieved by double clicking or striking the enter key while the cursor is in column A.

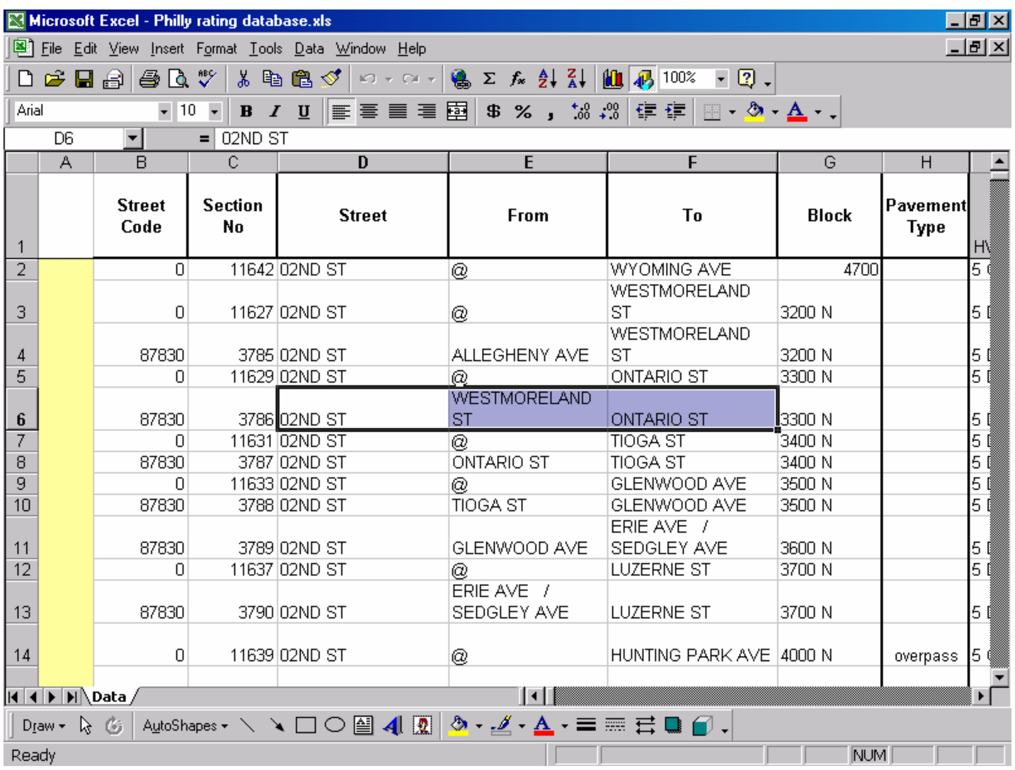
3. After the double clicking in column A, an input of surface type is required by the program. This input box prompts the user for the surface type by requesting, "Please enter pavement; F for flexible, R for rigid and O for other pavements."

4. Entering one of these letters will open the appropriate user form. For example, if "F" is entered for a flexible pavement section, then the user form displayed in figure 6 will appear.

5. As shown in figure 6, the flexible pavement user form has tabs A through G. Each of these tabs correlates to the letter labels used in figure 2 for the distress codes on the flexible pavement survey form.

6. When using the computerized forms, the necessary blank fields quality control checks were placed in the computer code to assure that the form is completely filled out before it can be closed. For example, the flexible pavement computerized condition form, as shown in figure 6, is completed by filling in the number of lanes of traffic on the street or intersection and selecting the proper flexible pavement type. Also, the appropriate severity and extend for the seven distress types on the tabs A through G must be selected by marking the corresponding number on the extent-severity table. Once these fields have been completed, the “Result” button is selected and the results are shown in the blank boxes above and to the left of the extent-severity tabs. Also, as the surveys are completed the results are recorded in the spreadsheet. An example of a completed survey form is displayed in figure 7.

7. If no distresses are present on the pavement section, the “None” button may be used to fill in the value of “None” for all distress types. This is a time saving feature when surveying sections that are in good shape. When the survey is finished and the results have been displayed, the “OK” button is selected and the user is returned to the spreadsheet and may select another section to be surveyed. Similar rating forms were developed for the rigid and other pavement types.



	Street Code	Section No	Street	From	To	Block	Pavement Type
2	0	11642	02ND ST	@	WYOMING AVE	4700	
3	0	11627	02ND ST	@	WESTMORELAND ST	3200 N	
4	87830	3785	02ND ST	ALLEGHENY AVE	WESTMORELAND ST	3200 N	
5	0	11629	02ND ST	@	ONTARIO ST	3300 N	
6	87830	3786	02ND ST	WESTMORELAND ST	ONTARIO ST	3300 N	
7	0	11631	02ND ST	@	TIOGA ST	3400 N	
8	87830	3787	02ND ST	ONTARIO ST	TIOGA ST	3400 N	
9	0	11633	02ND ST	@	GLENWOOD AVE	3500 N	
10	87830	3788	02ND ST	TIOGA ST	GLENWOOD AVE	3500 N	
11	87830	3789	02ND ST	GLENWOOD AVE	ERIE AVE / SEDGLEY AVE	3600 N	
12	0	11637	02ND ST	@	LUZERNE ST	3700 N	
13	87830	3790	02ND ST	ERIE AVE / SEDGLEY AVE	LUZERNE ST	3700 N	
14	0	11639	02ND ST	@	HUNTING PARK AVE	4000 N	overpass

Figure 5. Selection of section to be surveyed

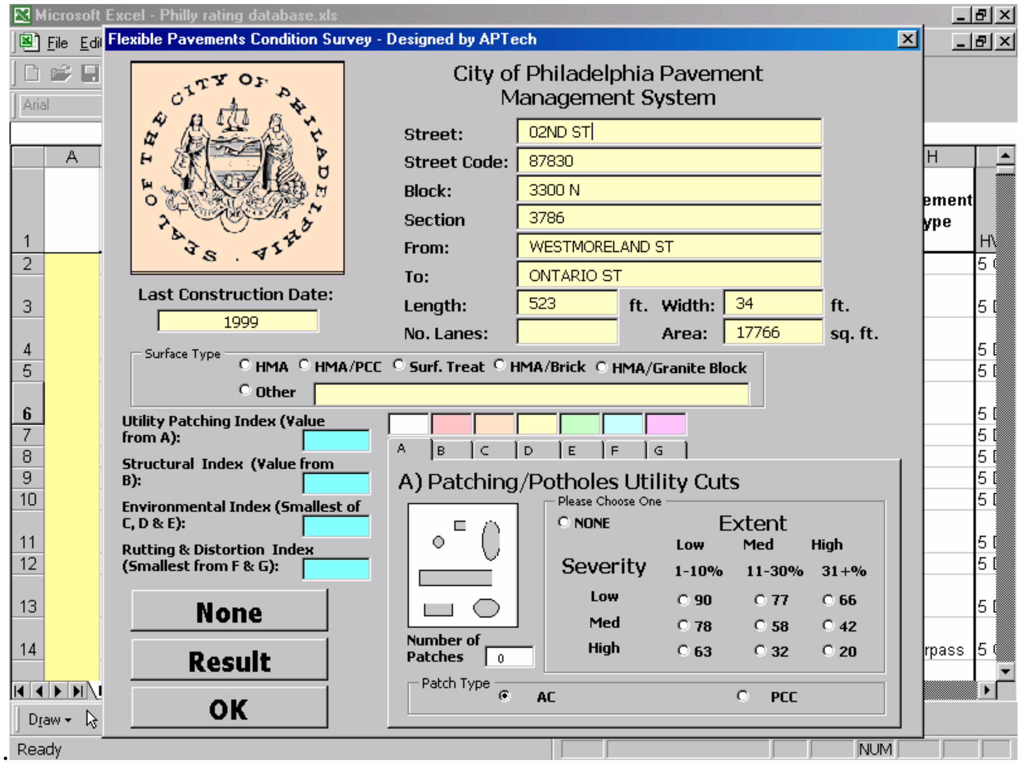


Figure 6. Flexible pavement type condition form.

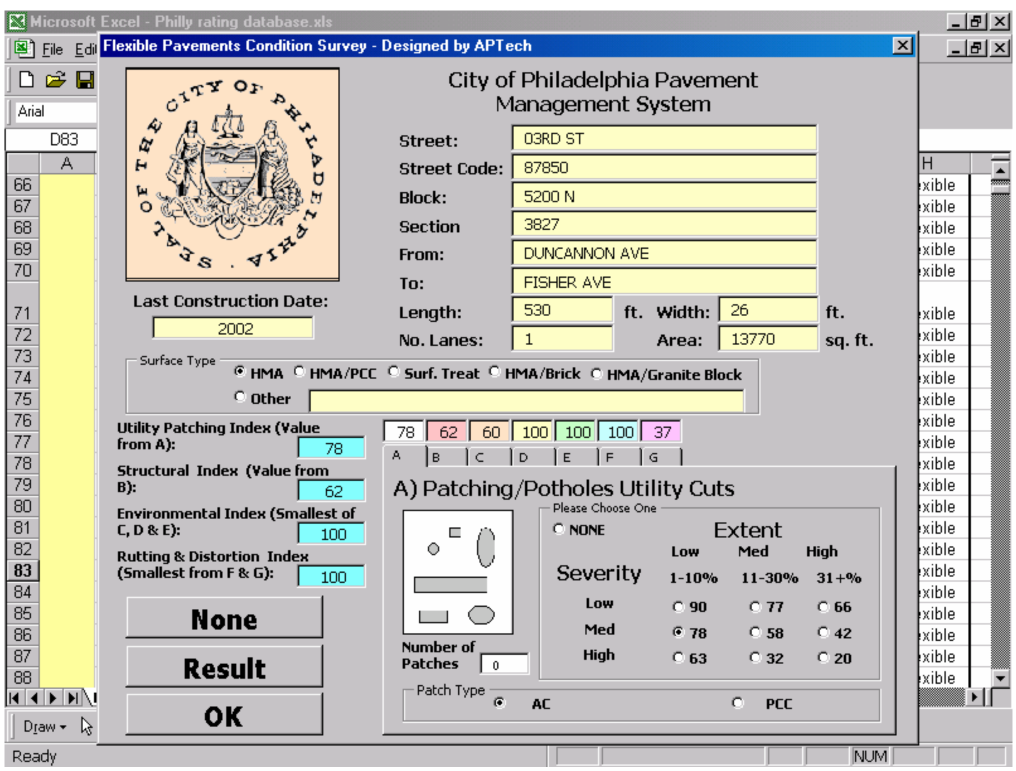


Figure 7. Completed flexible pavement survey form.

Production Rate

As with any new procedure, time is required to familiarize staff with the process to make needed modifications to the initial process. This rating method was no different than the norm. During the surveys, laptops were utilized for accessing the computerized rating form and rating and storing the completed survey data. An initial half-day of training to assure proper identification of distress types and familiarize users with the survey form and use of the laptop was necessary.

As time progressed, the survey production rates increased until a plateau was reached at approximately 300 sections sampled per 8-hour crew day. Condition of the streets being rated, traffic levels, and weather were all factors that affected the production rate of the surveys.

Production rates were also dependent upon the number of blocks versus intersections rated. A higher production rate was achieved in areas with higher numbers of intersections due to the small area of each intersection relative to a block. The blocks and intersections were rated separately because the City wanted to trigger work only due to the maintenance and rehabilitation needs of the blocks. If a given block is triggered for work then the corresponding intersection will also be considered to receive the treatment.

INDICES AND EFFECT OF UTILITY PATCHING

With the results of the surveys, the final indices and assessment of the effect of utility patches were assessed. A total of six indices were selected for use in the pilot implementation of pavement management system in Philadelphia. The six indices included a utility patching index, a structural index, an environmental index, a rutting and distortion index, joint deterioration index, and an overall condition index.

For flexible pavements, the utility patching index is the score for the patching and/or utility cut distress. Likewise the structural index is computed from the minimum score assigned to the alligator cracking or pothole distress. The environmental index is computed by taking the minimum value assigned to longitudinal/transverse cracking distress, block cracking or weathering/raveling. The rutting distortion index is computed by taking the minimum score assigned to transverse distortions or rutting/depressions.

For rigid pavements, the utility patching index is computed the same as for flexible pavements. The score computed is the patching and/or utility cut distress value. The structural index is computed by determining the minimum score assigned to divided slabs, corner breaks, or longitudinal and transverse cracking. Lastly, for rigid pavements, the minimum score of joint spalling and faulting determines the joint condition index.

The overall condition index is computed in a slightly different fashion for each pavement type. Presently, the overall condition index for HMA pavements is computed by using the *maximum* value of equations 3 and 4 as shown in equation 5.

$$OFCI_1 = (0.4 * UPI + 0.4 * SI + 0.1 * EI + 0.1 * RDI) - 1.25 * Stdev(UPI, SI, EI, \text{and } RDI) \quad (3)$$

$$OFCI_2 = Minimum\ (UPI, SI, EI, \text{and } RDI) \quad (4)$$

$$OFCI = Maximum\ (OFCI_1 \text{ and } OFCI_2) \quad (5)$$

Where:

OFCI = Overall Flexible Pavement Condition Index
UPI = Utility Patching Index
SI = Structural Index
EI = Environmental Index
RDI = Rutting and Distortion Index
Stdev = Standard Deviation

For PCC pavements the overall index will be computed using the *maximum* value of equations 6 and 7 as shown in equation 8.

$$ORCI_1 = (0.4* UPI + 0.4* SI + 0.2JDI) – 1.25*Stdev(UPI, SI, and JDI) \quad (6)$$

$$ORCI_2 = Minimum (UPI, SI, and JDI) \quad (7)$$

$$ORCI = Maximum (ORCI_1 \text{ and } ORCI_2) \quad (8)$$

Where:

ORCI = Overall Rigid Pavement Condition Index
JDI = Joint Deterioration Index

The overall condition index for the pavement surfaced with non-flexible and non-rigid surfaces was determined based upon the guidelines detailed in figure 4.

Originally, the overall condition indices for flexible and rigid pavements were going to be calculated based upon a simple weighted average. However, the results from the use of such an index showed a very tight distribution of indices and a very high average condition. It was determined that such a tight distribution of the conditions would cause future problems during the analysis stages of the pavement management system implementation. Therefore, the calculation of the overall condition index was further investigated and the above equations were developed.

Individual distress indices were used to trigger treatments for pavement sections in the pavement management system. The overall condition index was used to prioritize sections and as a method of reporting the general condition of the network and determining the benefit associated with a particular treatment.

Calculated indices were used to perform a preliminary analysis of how many pavements needed overlays. For this analysis, a decision was made to evaluate only the flexible city blocks within the 5th Highway District. A discussion with the City of Philadelphia provided the appropriate trigger values needed to assess the effect of utility patching on the need for overlays. The City of Philadelphia indicated that condition index values of 70 or less for patching, structural, or rutting and distortion indices would potentially trigger overlay work on a flexible pavement street section.

There were a total of 4,267 blocks within the 5th Highway District that were used in this analysis. Of these blocks, 894 blocks required an overlay based on the patching, structural or rutting and distortion index. Of those, a total of 718 blocks were triggered due to the structural or rutting and distortion index. Therefore, a total of 176 sections were triggered solely due to the utility patching index. Based on this calculation, 19.7 percent of the total sections needing overlays were triggered solely due to utility patching, which corresponds to 16.5 percent of the total pavement area needing overlays. Table 1 summarizes the calculations for the effect of utility patching index on triggering the need for overlays.

Although this analysis of the effect of utility patching is somewhat simplistic, it provides an indication of severity of the utility patching effect on Philadelphia's street network. Effectively 15-20 percent of Philadelphia's overlay program is dedicated to repairing streets whose primary deterioration is utility cuts and patches. Further investigation of this problem is planned by the City as they are developing ordinances to address this problem.

Table 1. Effect of utility patching index on the need for overlays.

Item	Number of Blocks	Percentage of Blocks	Area (sy)	Percent of Area
Total number of blocks used in analysis*	4267	100%	7,564,549	100%
Overlay triggered based upon (patching index OR structural index OR rutting & distortion index) < 70	894	21.0%	1,645,286	21.7%
Overlay triggered based upon (structural index OR rutting & distortion index) < 70	718	16.8%	1,374,514	18.2%
Difference in quantity of overlays if no utility patches existed in the 5th District	176	4.1%	270,773	3.6%
Percent of overlays triggered solely due to utility patching.		19.7%		16.5%

* Only blocks which are flexible pavements were considered, no intersections were included in this analysis.

SUMMARY

The City of Philadelphia's Department of Streets is facing the same operational issues of many large cities. One of the most significant issues is the increase in utility penetrations that are made each year, with the City of Philadelphia estimating 20,000 penetrations into the City's streets due to utility work each year.

At this time, the City is implementing a pilot pavement management system for its 5th Highway District in order to support its planning needs. The pavement management system will not only aid in determining the best use of available funding but will also be linked with the Department's Guaranteed Paving Information System (GPIS) which will be used to coordinate utility cuts with scheduled street maintenance and reconstruction activities.

During the implementation of the pavement management system for the City, a computerized distress collection form to collect the necessary information for the pavement management system was created. The details of the survey procedure and how the computerized form was developed based upon paper survey forms were discussed. The surveys also focused on the collection of information to quantify the impacts of utility cuts on the street network in Philadelphia.

From the survey data, multiple condition indices were computed for the flexible, rigid and other pavement surface types: overall, patching, structural, environmental, rutting and distortion, and joint deterioration. Treatment trigger values based upon these indices were selected in order to determining sections requiring overlays to quantify the impact of utility cuts.

A total of 19.7% of the blocks included in the analysis displayed a need for an overlay. Of these blocks requiring overlays, the analysis also showed that 16.5% of the area was triggered solely by utility patching.

REFERENCES

American Society of Testing and Materials (ASTM). 1999. *Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys.* ASTM D6433-99. American Society of Testing and Materials, West Conshocken, PA.

Federal Highway Administration (FHWA). 2000. *Georgia's Pavement Preservation Program and Smoothness Requirement – Smooth Pavements Don't Have to Cost any More Than Rough Pavements – Technical Details*. Federal Highway Administration, Southern Resource Center, Atlanta, GA.

Shahin, M. Y. and S. D. Kohn. 1981. *Pavement Maintenance Management for Roads and Parking Lots – Technical Report M-294*. U.S. Army Construction Engineering Research Laboratory, Champaign, IL.