PAVEMENT CONDITION INDEX **101**

There are two ways to measure the condition of a road network. The first way is to call it the Squeaky Wheel, sit back and wait for the complaints. The more complaints, the worse the condition of the roads. The second way is to use a more thorough, comprehensive and pro-active approach to review the entire road network.

The Pavement Condition Index is a simple, convenient and inexpensive way to monitor the condition of the surface of roads, identify maintenance and rehabilitation needs, and ensure that road maintenance budgets are spent wisely.

Pavement Condition Index Basics

What It Is: The Pavement Condition Index rates the condition of the surface of a road network.

The PCI provides a numerical rating for the condition of road segments within the road network, where 0 is the worst possible condition and 100 is the best.

What It Measures: The PCI measures two conditions:

- The type, extent and severity of pavement surface distresses (typically cracks and rutting)
- The smoothness and ride comfort of the road

How To Do It: The PCI is a subjective method of evaluation based on inspection and observation.

It is neither a complex nor time-consuming exercise. Knowledgeable and experienced public works officials drive the road network and evaluate its condition in a systematic way. The observations are entered into a database for evaluation and use.

The PCI should be conducted annually so that changes in road condition can be evaluated.

What It Provides: The PCI tells public works officials

- The current condition of the road network
- The rate of deterioration of the road network over time

PCI Uses and Benefits:
A PCI is used to:

- Identify immediate maintenance and rehabilitation needs
- Monitor pavement condition over time
- Develop a network preventive maintenance strategy
- Develop road maintenance budgets
- Evaluate pavement materials and designs

Setting Up a Performance Condition Index

While the PCI is based on subjective observations, the index itself must be both objective and systematic to be of value.

A PCI needs to be based on:

- Manageable road sections
- A roads inventory
- A classification and rating system for road defects

Road Sections: In order to develop a PCI, the road network needs to be divided into manageable segments. Sections with relatively uniform pavement structures, design and traffic volumes will have similar performance characteristics.

In urban settings, sections should be kept to a manageable length, typically one block long. Some road authorities limit the length to 150 metres for problematic sections. Other authorities will use longer segments for roads that are consistent throughout their length.

> "Virtually everyone – residents, visitors, pedestrians, passengers, commercial and private car drivers and anyone with a window-view of a block front – experiences the streets and observes their condition. People know that it is city government's responsibility to maintain them. For many, then, the performance of local government itself is evaluated by the condition of the streets."
>
> How Smooth are New York City's Streets? Fund for the City of New York, September 1998,

Road sections in rural settings can be considerably longer, in some cases as much as 10-kilometres.

Each road section needs a unique identification so that the PCI observations can be maintained in a database.

Road Inventory: Each road section should have a basic history attached to it:

- Class - local residential, collector, or arterial
- Length, width, and geometry
- Type and volume of traffic
- Pavement type - flexible, rigid, or composite
- Original construction date
- Maintenance and rehabilitation history
- Current condition based on the last PCI

Road Defects Classification

Inspectors need to know what type of surface defects to look for and a checklist to track their observations. Typical surface defects include:

Surface Defects
- Ravelling & Loss of Surface Aggregate
- Flushing

Surface Deformations
- Rippling and Shoving
- Wheel Track Rutting
- Distortion

Cracking
- Longitudinal Wheel Track Single and Multiple, Alligator
- Centerline Single and Multiple, Alligator
- Pavement Edge Single and Multiple, Alligator
- Transverse Single and Multiple, Alligator
- Longitudinal - Meander or Mid-lan

Inspectors also need a working knowledge about the causes of surface defects. Defects are typically symptoms of one or more underlying problems. Thermal stresses, for example, cause cracking, but cracking can also be the result of a weak base. Rutting can be a symptom of a weak sub-base or instability in the pavement. Different causes call for different remedies.

Conducting a PCI

The Drive Through:

A PCI is developed based on visual inspection and observation – sometimes called a "windshield inspection".

Ideally, two people should do the inspection together – one driving while the other takes notes – and both evaluating the pavement as they go.

Start by driving along the road section at the posted speed in one direction to evaluate the ride comfort. Then do a repeat drive through at a lower speed (about 30) examining the full width of the road for defects.

The inspectors are looking for the frequency and severity of specific surface defects on the checklist. They should also be making observations as to whether the road section is fulfilling its function and how well it compares to other roads.

A digital photograph of each section of roadway provides a permanent record of the pavement condition.

Data collection tools can simplify the task. Laptops and PDAs can record and upload data. GPS units can pinpoint locations accurately. But paper and pencil still works.

Evaluating Surface Distresses:

Surface distresses are evaluated based on type, frequency and severity.

MTO SP-024 – Manual for Condition Rating for Flexible Pavements gives a good description of the types of defects and how they should be evaluated. Note that there are different criteria for asphalt, concrete, and composite pavements and for gravel roads.

The following form can be used by inspectors to record distresses (and the evaluation for a local road in relatively good condition).

Ride Comfort Rating:

Ride comfort is a subjective assessment of how the public would rate the quality of the pavement.

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				Severity of Distress (Si)					Density of Distress (Di)				
				Very Slight	Slight	Moderate	Severe	Very Severe	Few	Intermittent	Frequent	Extensive	Throughout
									<10	10-20	20-40	40-80	>80
Pavement			**Wi**	1	2	3	4	5	1	2	3	4	5
Surface Defects		Ravelling & loss of surface aggregate	3.0		x					x			
		Flushing	1.5		x					x			
Surface Deformations		Rippling and Shoving	1.0	x					x				
		Wheel Track Rutting	3.0	x					x				
		Distortion	3.0		x					x			
Cracking	Longitudinal Wheel Track	Single and Multiple	1.5	x					x				
		Alligator	3.0	x					x				
	Centerline	Single and Multiple	0.5			x					x		
		Alligator	2.0	x					x				
	Pavement Edge	Single and Multiple	0.5			x					x		
		Alligator	1.5			x					x		
	Transverse	Half, full and multiple	1.0	x					x				
		Alligator	3.0	x					x				
	Longitudinal – meander or mid-lane		1.0		x					x			
	Random		0.5										

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8 – 10	Excellent	Very smooth
6 – 8	Good	Smooth with a few bumps or depressions
4 – 6	Fair	Comfortable with intermittent bumps or depressions
2 – 4	Poor	Uncomfortable with frequent bumps or depressions
0 – 2	Very Poor	Uncomfortable with constant bumps or depression

Consistency:
While every effort should be made to ensure that the PCI is as objective as possible, it is still based on the subjective observations of those doing the inspection.

If a PCI is to be used to track the deterioration of a road network over time, the observations of subsequent PCIs need to be comparable. It is, therefore, important whenever possible to use the same people to do the inspection each year.

Calculating the PCI

There are plenty of software programs available to help calculate and record the PCI for a road section (Municipal DataWorks, for example, has a PCI tool), but the calculations are relatively straightforward and can be done by hand or with the aid of a spreadsheet.

Since each type of surface distress indicates a different type of problem, some more severe and some less, each distress is given a weight to reflect its importance in a rehabilitation strategy (shown as "Wi" in the table).

The numerical rating for the severity of the distress and for the density of the distress are combined and then multiplied by its weight. The sum of all the distresses gives the DMI (Distress Manifestation Index) for the road section.

The inspector also rate the Ride Comfort Rating at posted speed, assigning it a numerical rating between 0 and 10, where 10 is equivalent to a brand new road.

The PCI can then be calculated using either a software program or by hand based on well-established formulas. Take for example a local road in relatively good condition (see chart above for the evaluation sheet) with a road comfort rating of 7. The calculated value of the PCI is 72.5.

This PCI is used as a guide to rehabilitation and maintenance decisions for the road network based on a decision matrix (see Making Decisions below).

Using the PCI

Making Decisions:
The PCI decision matrix provides specific guidelines for the improvements required for various road classifications. Using the PCI can help identify trigger points for preventive maintenance that can stop a road deteriorating to the point that it needs expensive rehabilitation.

As a rule of thumb, the higher the PCI, the better condition the road is in. In the previous example, a local road with a PCI of 72.5 will probably not need any rehabilitation work for at least six years.

The PCI decision matrix is a guideline and should be used in conjunction with the personal observations of the road inspectors. Municipalities can adjust the matrix to provide alternative trigger points for rehabilitation or reconstruction. Specific maintenance and rehabilitation actions should always be based on the actual distress of the pavement itself.

Asset Management:
The PCI identifies roads that are exhibiting distress and at the network level can help categorize maintenance and rehabilitation requirements for budgeting and planning.

The PCI, as a condition rating index, can be used effectively with other asset management programs. The condition rating identifies the remaining useful life of an asset and assists with developing rehabilitiation and replacement strategies for a particular asset.

PCI Limitations

The Pavement Condition Index is a useful tool but it has its limitations.

- It is subjective. While most people would agree on which roads are rated as excellent and which ones are rated as poor, deciding on whether a road is in fair condition or good condition is more difficult. Being too lenient may mean that important maintenance work is delayed. Being too strict may mean spending money on fixing a problem before it really needs to be done.

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PCI Decision Matrix

TIME OF IMPROVEMENT	FREEWAY	ARTERIAL	COLLECTOR	LOCAL
Adequate	>85	>85	>80	>80
6 to 10 years	76 to 85	76 to 85	71 to 80	66 to 80
1 to 5 years	66 to 75	56 to 75	51 to 70	46 to 65
NOW Rehabilitate	60 to 65	50 to 55	45 to 50	40 to 45
NOW Reconstruct	<60	<50	<45	<40

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- It deals with surface conditions only. Surface conditions are symptoms of underlying problems and need to be properly diagnosed. In the worst case, there can be severe distresses below the pavement with no visual signs of distress. Other testing and inspection methods (a profilograph to measure smoothness, for example, or load deflection testing to analyze structural strength) should be used to quantify specific pavement conditions. Other factors such as capacity, drainage, surface width, shoulder width, horizontal and vertical alignment and geometrics should be considered in the pavement analysis.
- It is only one tool. The PCI provides a broad overall measure of the state of a road network and can help prioritize specific road maintenance and rehabilitation requirements. It is not the only way to evaluate a road network and should be used in conjunction with other asset management tools. Consultants with specialized equipment can complete a more objective review of the entire road network. **M**

Pavement Condition Index 101 is part of an on-going Milestones series introducing road management, maintenance and rehabilitation techniques. Previous topics were Chip Seal 101 and Potholes 101.

The Pothole Killers

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stream of air to clear debris and dry the pothole. He then opens a nozzle and applies a layer of tack coat for good adhesion. The machine fills the hole with a mixture of aggregate and liquid asphalt, leaving a slight crown, and then tops the patch with a thin layer of crumb rubber. Traffic can drive over the patch as soon as the Pothole Killer leaves.

The Pothole Killer can be used throughout the year, operating at temperatures as low as -20°C in the winter and as high as 40°C in the summer.

"We use a proprietary blend of materials in our asphalt cement to manufacture a warm asphalt than can be applied at lower temperatures than conventional hot mix, about 70°C. The crumb rubber, which leaves a smooth black aesthetically pleasing surface, is made from used tires. So the process is not only efficient but environmentally friendly as well," says Scott Kleiger, chief operating officer of Patch Management.

But it is the speed and cost that are the real selling points. The Pothole Killer fills between a hundred and three hundred holes a day, without having to shutdown roads or delay traffic.

Filling a pothole manually with a crew of four costs about $30, says Kleiger. In Washington DC, the cost using the Pothole Killer is about $10.

Patch Management, has headquarters in Pennsylvania and four operating centres. Road agencies can either lease the Pothole Killer or Patch Management will do the maintenance work under contract.

The Pothole Killer is currently being used in a number of US states including New York, Virginia, New Jersey, Texas, and California. And, Kleiger says, there has been interest north of border, too.

"We have had inquiries from Toronto and Winnipeg," he says. "Potholes are a bit like a virus. They don't respect borders. We hope to have the Pothole Killer available in Canada in the spring of 2010 in time for the next pothole season." **M**

For more information go to potholekillers.com

The OMKN Spotlight is a regular Milestones feature, highlighting municipal best practices and excellence in service delivery from the Ontario Municipal Knowledge Network.

The Ontario Municipal Knowledge Network is a web-based resource providing information on Gas Tax Funding beneficial practices and award winners along with regular updates from other jurisdictions on innovations in a wide range of municipal service delivery and operational areas.