A Study on Pavement Network Condition and Reporting in the Province of Alberta Through a Questionnaire Survey

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Abstract

Government agencies such as municipalities own several lane kilometers of roadways all in varying conditions depending on their traffic loads, environment, material types, and construction methods. Managing a vast inventory of assets can be challenging and depending on the size of the municipality, sufficient resources may not always be present for municipalities to accurately understand their networks' needs. Size of municipalities not withstanding, funding to maintain these networks always remains a challenge. Finite funds are constantly competing against other priority infrastructure as well as politically motivated projects being broadcasted the loudest. Moreover, not all networks are created equal; some networks may be more rural and require different treatment and maintenance needs compared to an exclusively urban environment. Understanding all these parameters is critical in order to grasp the complexities and challenges that Alberta municipalities and agencies face when maintaining their transportation networks. To determine these answers, a questionnaire survey was conducted to the Pavement Management Users Group in Alberta. The results showed several consistencies related to the use of traditional pavement treatment methods, such as mill, overlay, and conventional reconstruction. This study noted, however, that there exists a gap in the use of preservation methods, such as microsurfacing, being used around the province of Alberta, as well as staff resource and asset management challenges. This survey provides a unique insight into the treatment selections and resources dedicated to roadways and strategies around the province.

Keywords: Pavement Management, Hot Mix Asphalt, Preservation, Municipalities,

Agencies.

Introduction

Roadways are major utilities and are vital to any community; they are a main contributor to the economy of a city, while simultaneously acting as a social connection for residents to live. These are some major reasons that maintaining these utilities is just as vital, if not more vital, as similar services such as water and waste-water utilities. Despite the necessity of roadways, very few people are familiar with the required and detailed process of determining project locations, necessary treatments, and the required funding for the next year and beyond. Pavement Management is not well understood by the general public, yet remains a vital practice within asset management and engineering, since it requires the practice of regular inspection along with data driven decisions. According to AASHTO, "maintenance organization should have a system, preferably automated, that will project its maintenance requirements for a sufficient number of years, avoiding situations that will cause severe fluctuations in maintenance employment." [1].

As with any databases and analytics that go along with systems created by asset management and engineering, the output qualities are only as good as the data and processes that produce them. Effectively, the data that is relied on to spend millions of capital dollars every year is only as good as the quality of the data and the analytics behind it that produce the metrics. So, what are these measurements and parameters? Where do they come from? And who uses them? To answer above questions, the author approached a group of pavement managers and professionals from different municipalities and agencies across Alberta to help provide insight. In Alberta, several municipalities are part of a joint group called the "Pavement Management User Group" (PMUG). This group meets annually to discuss the many issues related to pavement management, including but not limited to:

- New tools and techniques related to pavement management
- Materials and performance
- Maintenance practices
- Upcoming technologies and alternatives

Prior to the PMUG annual meeting in 2017, a survey was sent out to all members of the group. This survey was designed to determine key information about the group including:

- An agency's network size and condition levels
- Number of available resources
- Assets that were reported
- Treatments that are employed most and least frequently

A total of 34 questions were asked to all members, with responses from 13 unique agencies listed below:

1. City of St. Albert
2. City of Spruce Grove
3. City of Edmonton
4. Parkland County
5. Town of Canmore
6. City of Lethbridge
7. City of Medicine Hat
8. Strathcona County
9. City of Leduc

10. City of Calgary
11. City of Grand Prairie
12. City of Red Deer
13. Alberta Transportation (only provided answers to less than 10% of questions)

The results were then collected, tabulated, analyzed, and subsequently presented to the group on April 27, 2017.

Overview of Important Parameters

The PMUG uses standardized metrics with use of the Stantec pavement management software's: Road Matrix and the Highway Pavement Management Application (HPMA). These metrics are used to measure pavement condition to ensure that all data can be compared on the same level. There are four main measured indices taken from roadway measurements:

- *Ride Condition Index (RCI)*

The Ride Condition Index (RCI) is an index with a range from 0–100 that represents the overall "perceived roughness" in the tested section. An index of 100 represents an extremely smooth surface [2]. Effectively, this index can be most easily explained as "how bumpy is the road".

- *Surface Distress Index (SDI)*

The Surface Distress Index (SDI) is an index with a range from 0–100 that represents the level and type of distress found in the tested section. The SDI is calculated based on a "severity and extent" index for each type of distress. The severity describes the overall condition of the distress, while the extent describes its level of presence in the section. The severity is a range of 0–2, with 2 being severe [2], while the extent is a range of 0–4, with 4 being highly present within the surveyed area.

- *Structural Adequacy Index (SAI)*

The Structural Adequacy Index (SAI) has a range from 0–100 and represents the structural capabilities of each section to carry loads. 100 represents a good condition of strength in the road. This number is calculated indirectly from falling-weight-deflectometer testing (FWD), a device that delivers a series of loads on the ground and measures the response. An index greater than 50 typically represents that the structure is able to continue carrying its current load, while an index less than 50 shows that the support is inadequate [2].

- *Pavement Quality Index (PQI)*

The Pavement Quality Index (PQI) is the overall "score" given to a section with a range from 0–100. 100 represents a road in excellent condition (usually when it is initially constructed). PQI is an output metric that is a function of RCI, SDI, and SAI. These parameter relationships can be represented as PQI=f (RCI, SDI, SAI). It is important to understand that PQI is not a measured value but is the product of three other measured parameters.

Survey Results

The results of the survey can be summarized into four main parts:

1. Available internal resources
2. Infrastructure & asset reporting
3. Frequency of data collection
4. Reported results

To maintain anonymity of agencies' data, the names and locations of the responders have been stripped out of this report. The data has been aggregated together to create a snapshot of the current state of transportation infrastructure throughout the province of Alberta. The following is a small excerpt of the data reviewed as part of this survey:

Available Internal Resources

As part of the survey, agencies were asked to report on how many full-time staff make up their departments responsible for directly contributing to maintaining roadway infrastructure. They were asked a series of questions such as available internal staff and population. TABLE 1 shows that most agencies have less than five internal, full time staff managing their transportation infrastructure. This data was the most consistent selection regardless of population size of the agency. However, population size was not necessarily a good indicator of network complexity or needs. Since small populations can be in large areas, like rural counties. Another way to evaluate this issue was to consider available staff versus the actual lane kilometers that the agency was responsible for. Furthermore, TABLE 1 also shows that as the agency lane kilometers grew, the more resources were required to maintain and review the network. Even still, there were still agencies that had 4,000 or more lane kilometers that only had five or less professionals responsible for reviewing the network.

TABLE 1 - Number of Pavement Management Staff by Agency Citizen Population and Network Lane Kilometers

Internal Staff Available	***Population***					***Agency Lane Kilometers***				
	<30,000	30,000 – 50,000	50,000-75,000	75,000-100,000	>100,000	< 500	500-1,000	1,000-2,000	>4,000	No Answer
<5	1	1	3	1	2	3	2	2	1	
5 to 10		1							1	
10 to 15		1			1	1			1	
15 to 30				1	1					2

Infrastructure and Asset Reporting

As part of their data collection, agencies are often asked to report both internally and externally on the current state of road infrastructure. This reporting helps to show the current network status to decision makers ultimately responsible for controlling how much funding the agency's infrastructure would receive. However, not all agencies possess the same types of infrastructure in their network. As TABLE 2

shows, all surveyed agencies have some asphalt roadways in their inventory, and nearly all agencies have rural gravel roads and back lanes. The numbers then drop off when it comes to concrete pavements and parking lots.

TABLE 2 - Infrastructure owned by agencies based on survey results

Asset Type	**Percent of Agencies that Own and Maintain this Asset Type (Number of Agency Response)**
Asphalt Surfaces-Highways, Arterials, Collectors, Local Roads	13
Rural/Gravel Roads	12
Asphalt Alleys/Lanes	12
Parking Lots (Asphalt Surface)	9
Other	5
Concrete Surfaces-Highways, Arterials, Collectors, Local Roads	4
Concrete Alleys/Lanes	3

The results were consistent on types of infrastructure owned by government agencies. Most have some form of paved surfaces. However, when the data was reviewed further as to what is actually reported on, there were some major differences between infrastructure that was owned at the time, and infrastructure that was reported on as shown in TABLE 3.

TABLE 3 - Infrastructure reporting in network based on survey results

Asset Classification	**Percent of Agencies Reporting on the Asset (Number of Agency Response)**
Arterials	13
Collectors	13
Locals	13
Lanes/Alleys	8
Highways	5
Rural Roads- Paved	5
Trails	2
Sidewalks	1
Rural Roads - Non Paved	1
Parking Lots	1

TABLE 3 shows consistency for agencies to report on major paved roads; however, the reporting dropped off significantly when reviewing lanes/alleys and parking lots. Only 8 and 1 of agencies reported all lanes/alleys and parking lots, respectively. Even less reporting was done on secondary infrastructure like

trails and sidewalks (2 and 1 respectively). This lack of reporting is important since it shows that most municipal agencies may not know all the information related to issues like trip hazards. This lack of detail is unfortunate, as the costs of removal of a sidewalk trip hazard can be very low, as low as $50 per issue by way of sidewalk cutting.

The survey also solicited feedback on types of maintenance treatments used in Alberta. The results of the data are summarized in TABLE 4.

TABLE 4 - Treatment types in Alberta

Treatment Type	**Percent of Agencies that use the Treatment (Number of Agency Response)**
Hot Mix Asphalt Overlay	13
Crack Sealing	12
Pot Hole Repair/Small Area Patching	12
Full Reconstruction	11
Spray Injection	9
Microsurfacing	7
Full Depth Reclamation	4
Chip Sealing	3
Hot In Place Recycling	3
Restorative Seals - Eg: Fog Seal	1
Cold In Place Recycling	1

As shown in TABLE 4, there is a tendency for Alberta agencies to default to traditional road restoration and rehabilitation options (such as hot mix asphalt overlays or reconstructions) rather than preventative activities such as microsurfacing.

Frequency of Data Reporting

Data for government agencies must be collected with some regularity and consistency. This helps to ensure that modeling is matching real conditions and ensures that decisions are being made in the short term on the most up to date information. While there is a requirement for agencies to collect data on their network, the requirements do not specify the data collection frequency. As TABLE 5 shows, there are a variety of options that agencies use.

TABLE 5 - Interval of Time Agencies Noted Data was Collected

Intervals of Data Collection	Number of Agencies
1/3 of the City each year	5
Arterial/Collector Annually	1
Full Network – Annually	1
Full Network – 3 Years	1
Full Network – 5 Years	2
Alternate Years of Each Category – 3 Years	2

The most common data collection schedule is 1/3 of the city each year. This option allows for agencies to spread out the cost of the data collection while still having relevant data renewal. The next two most common options are to alternate the asset categories (i.e. Arterials in year 1, Collectors in year 2, and Locals in year 3), or doing the full network every 5 years.

To assess the roads condition based on the describe metrics, automated equipment which consists of several sensors that measure surface distress, ride quality, and more depending on what is required by the tester. Survey results showed that data was overwhelmingly collected by private companies/consultants. Ten agencies mentioned their data was collected by consultant companies, while two were using internal recourses and only one mentioned the use of both consultant and internal resources.

It should be noted that there is a significant cost to purchases and operate this equipment is upwards of $1,000,000 [3].

Reported Results

All responding members of the PMUG were asked to provide their most up to date metrics on their road networks. This data shows an interesting snapshot of the state of the roadways in Alberta as of 2017, shown in TABLE 6.

TABLE 6 - Roadway Metrics Overview as Collected from Survey

Metric	PQI	RCI	SDI	SAI
Average	64.9	51.7	65.3	66.7
Standard Dev	6.4	5.5	7.6	16.3
Participants	10.0	9.0	9.0	8.0

TABLE 6 shows that the average PQI for responding agencies is 64.9. As previously stated, PQI is an overall score based on RCI, SDI and SAI. So the size of the network does not influence the value of the number. It also shows that the average RCI in all respondents was 51.7. Any number near 50 is considered to be at a “pivot point” for network noticeability of roughness in the roadways. In short, there was a consistency of roads being very rough in Alberta. When this was compared to the SDI of 65, it could be surmised that most of the roughness came from treatments like pothole patching and spray injection. Both pothole patching and spray injection are methods that repair the road’s surface, but at the cost of the comfort or “smoothness” of the roadway.

Discussions

Agency Resources vs population and network size

Agencies are constantly balancing the need for more resources and budgets. Politicians are commonly known for looking at ways to cut budgets to save on tax dollars. However, often the largest need for tax funds can come directly from wages paid to employees. As a result, some politicians go as far as to demand that agency policies surrounding the hiring of full time staff be tied to population size [4]. When managing complex transportation infrastructure, it is erroneous to correlate population size with needs of internal resources, as some of the largest transportation networks can reside in low density populated communities like rural counties. As TABLE 7 shows, further review of survey results reveal that population plays less of a role in resource needs than the size of the network.

TABLE 7 - Staff to Agency Service Population and Network Lane Kilometer Comparison

Agency size	Agencies with a population less than 50,000	Agencies with a population more than 50,000	Agencies with less than 1,000 Lane Km	Agencies with more than 1,000 Lane Km
Agencies with less than 5 staff	2	6	5	3
Agencies with more than 5 staff	2	3	1	4

TABLE 7 shows that agency lane kilometers were a better indicator of resource needs than that of population. Since the there were six agencies with more than 50,000 residents still operating with less than five full time staff. When the numbers were reviewed for lane kilometers, it can be concluded that a majority of networks that had more than 1,000 lane kilometers had more than five staff total.

An absence of preservation and in place recycling methods in Alberta

The data further revealed that Alberta is a province that continues to be a champion of traditional road resurfacing, restoration, and rehabilitation methods. Most agencies engage in a form of asphalt overlay work and full reconstruction, with only 50% of agencies using preservation methods like microsurfacing, and less than 20% using any form of recycling methods.

This survey data shows that agencies in Alberta may not be pursuing preservation in their networks actively. Preservation activities have been shown to have a significant effect on long term costs if they are used at the correct time in the road's life [5]. Additionally, with more and more scrutiny being done on the part of environmental impacts of projects, it may be of value to municipalities and government agencies to investigate technologies that allow for them to recycle their existing materials back into roadways. This economic approach not only saves capital dollars, but also limits the amount of volatile organic compounds (VOC's) and $C0_2$ into the atmosphere [6].

Stronger data collection on secondary infrastructure needed

This survey showed that there are likely very few agencies collecting and reporting on data related to secondary transportation infrastructure. This could result in problems relating to a particular and specific area of liability affecting agencies, especially municipal governments. Understanding where trip hazards and other serious issues appear in pedestrian networks is very critical, since these can be the sources of litigious issues for governments. In some cases, issues costing the municipality upwards of $100,000.[7]. Further research into the reporting on secondary transportation infrastructure could explore and determine what challenges exist in pursuing detailed reporting and condition assessment on said assets.

Conclusions

The Alberta Pavement Managers Group provides a significant insight into the current state of roadways in Alberta. This survey partly revealed that municipal agencies face a difficult issue of resources being traditionally tied to population growth rather than network size. Potentially making it difficult for more resources to become available as networks become larger and more complex. Additionally, there may be a place for preservation and recycling activities in Alberta. This topic could be further explored and discussed to understand why these techniques and treatments are not highly used.

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