Final Report

Methodology for the Development of Equivalent Pavement Structural Design Matrix for Municipal Roadways- Québec City and Montréal

Including Maintenance & Rehabilitation Schedules and Life Cycle Cost Analysis

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GLOSSARY OF ABBREVIATIONS

AADT - average annual daily traffic
AADTT - average annual daily truck traffic
ESALs - equivalent single axle loads
HMA - hot-mix-asphalt
JPCP - jointed plain concrete pavement
LCCA - life-cycle cost analysis
MEPDG - mechanistic-empirical pavement design guide
MTO - ministry of transportation, Ontario
MTQ - ministry of transportation, Québec
M&R - maintenance and rehabilitation
PCC - Portland cement concrete
PG - Performance grading
PW - present worth
SHRP - strategic highway research program

1. Introduction

Both rigid and flexible pavements are commonly used in Québec for both provincial highways and municipal streets. Each pavement type is designed and constructed based on local traffic and site conditions.

Rigid pavements in Québec typically consist of a Jointed Plain Concrete Pavement (JPCP) over a granular base/subbase which provides uniform support for the concrete slabs. The concrete pavement is placed over an MG 20 granular base with a granular subbase used in some areas subject to significant frost heaving action. The structural strength of a concrete pavement is largely within the concrete itself due to its rigid nature. Concrete's rigidness spreads the load over a large area and keeps the pressure on the subgrade low, which is why less base material is required. Portland Cement Concrete (PCC) pavements have been used in both highway and municipal applications around the cities of Montréal and Québec City.

Flexible pavements typically consist of Hot-Mix Asphalt (HMA) pavement over a granular base and subbase to distribute the traffic loads over the underlying layers. The asphalt concrete materials used in Québec municipalities typically consist of ESG 10 and ESG 14 asphalt surface and binder courses over MG 20 granular base and MG 112 granular subbase. Asphalt cement typically follows the Strategic Highway Research Program (SHRP) Performance Grading (PG) specifications.

Government agencies can benefit from a two-pavement system, where an agency is able to pave more roadways with the same amount of funding when compared to a single pavement system. Although concrete and asphalt have been used for municipal roads for decades, the use of alternate bids with life cycle cost as part of the tender process for pavement choice evaluation is fairly new. This process has been evolving in Canada since the first MTO contract tendered in 2001. The decision to use LCCA as part of the alternate bid process provides government agencies with better knowledge of the true cost of a roadway rather than just considering the initial cost of the pavement. Transport Québec (MTQ) has a policy on pavement type selection which applies to roadways under the Provincial jurisdiction. The policy, which is reviewed every 5 years, specifies concrete surface pavements for high volume roadways, asphalt surface pavement for low volume roads. The purpose of this report is to describe the pavement type selection process between concrete and asphalt pavements and to provide typical pavement cross-section information and accompanying M&R plans that are appropriate for use by Québec municipalities.

These designs are established to be structurally equivalent and have the same design life such that a fair comparison may be made. The M&R plans have been developed for both pavement types to ensure that the minimum level of service will be maintained through preventative maintenance and rehabilitation activities commonly used by Québec municipalities. It should be noted that the maintenance and rehabilitation plans for provincial highways tend to be more frequent than for municipal roadways due to differences in posted speed and the higher focus on pavement smoothness for the faster moving highways. The recommended municipal maintenance and rehabilitation plans have been established to provide a reasonable level of service throughout the asset life.

Creating equivalent pavement designs has historically been difficult due to differences in the pavement design procedures used for rigid and flexible pavements. However, the most recent

release of the AASHTO pavement design guide, the Mechanistic-Empirical Pavement Design Guide (MEPDG) (AASHTO, 2008), provides a more robust design procedure that uses substantially more design information and a larger source of data to calibrate the performance predictions than previous editions. Equivalent designs used in this document are based on the MEPDG.

This study includes pavement designs and maintenance plans for collector, minor arterial and major arterial roadways climate regions reflective of Québec City and Montréal.

2. Mechanistic Empirical Pavement Design Guide

The MEPDG is the pavement design guide developed for AASHTO under the U.S. National Cooperative Highway Research Program (NCHRP) Project 1-37A. The MEPDG uses mechanistic-empirical principles to predict the deterioration of pavements and their expected service lives. The design procedure is very comprehensive. It includes procedures for the analysis and design of new and rehabilitated rigid and flexible pavements, procedures for evaluating existing pavements, procedures for subdrainage design, recommendations on rehabilitation treatments and foundation improvements, and procedures for life cycle cost analysis.

The MEPDG uses state-of-the-practice mechanistic models to predict the accumulation of pavement distresses based on the traffic loads and the material properties. This process is repeated hundreds of thousands of times to account for all of the possible traffic load combinations and the changes in materials due to age and climatic conditions.

To ensure that the models closely represent the distress conditions of in-service pavements, the process was calibrated to match known performance information from the Long Term Pavement Performance study and other test tracks across North America. These comprehensive data sources have been used to perform an empirical calibration to the field conditions documented from over 20 years of detailed performance observations. The design procedures used in the Guide are based on mechanistic-empirical concepts, which are a quantum leap from the old AASHO Road Test empirical designs that are used by many Canadian transportation agencies.

Mechanistic-empirical design focuses on pavement performance and accounts for many factors that have not been well addressed previously. All of these new design inputs that directly affect pavement performance such as materials, climate, traffic loads and construction procedures are used to estimate the distress condition of the pavement over time (Figure 2.1).

One of the other major advancements of the MEPDG and the accompanying software is the ability to establish local calibration of the models. Since there are many differences in both the climate and materials used by different agencies, there are many factors that are expected to contribute to the variability in the analysis. As a part of the implementation of the MEPDG by Canadian transportation agencies, local calibration efforts are being completed to both develop the appropriate inputs as well as to monitor the performance of their pavements. The list of design inputs and applicable values developed for Québec are discussed in this report.

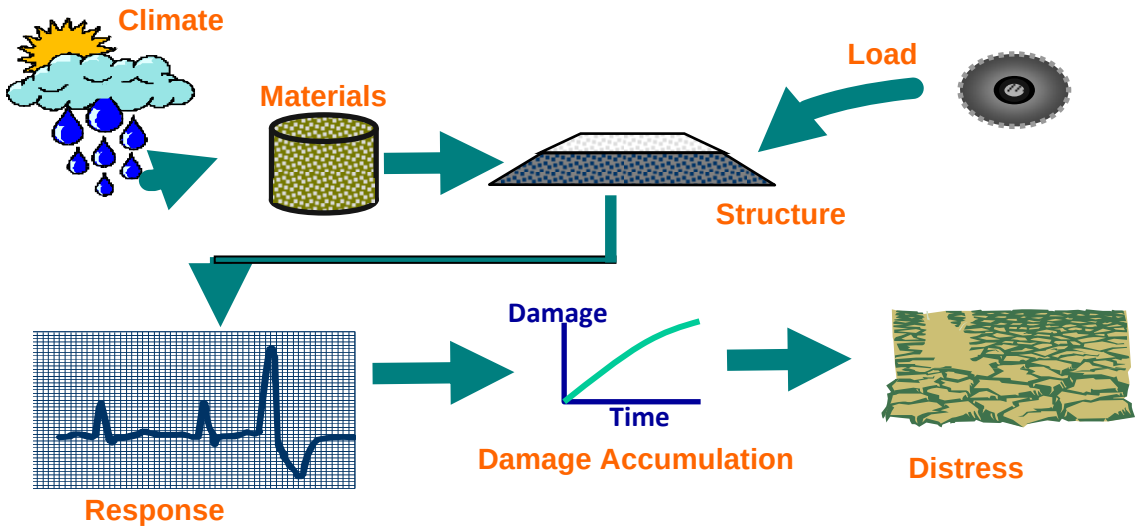


Figure 2.1 General Pavement Design Procedure and Analysis

The design inputs have been subdivided into categories for ease of implementation. The following inputs are used by the MEPDG to model the pavement performance:

- General Inputs
- General Information
- Site/Project Identification
- Analysis Parameters
- Traffic
- Traffic Volume Adjustment Factors
- Axle Load Distribution Factors
- General Traffic Inputs
- Climate
- Structure
- Drainage and Surface Properties
- Pavement Structural Layers
- Asphalt Concrete Layers
- Rigid Concrete Layers
- Granular Layers
- Foundation/Subgrade
- Thermal Cracking
- Distress Potential

2.1 Traffic Information

The volume and composition of traffic has always been a major focus of pavement design due to the impact it has on determining the thickness of the pavement. Traffic has been traditionally described as the number of vehicles using the road in terms of the Average Annual Daily Traffic (AADT). In the 1993 AASHTO Design Guide (AASHTO, 1993), the traffic was described in terms of Equivalent Single

Axle Loads (ESALs), which described the total damage caused by different vehicles in terms of the damage caused by 80 kN single axles.

The MEPDG takes a different approach to more accurately evaluate the damage caused by each axle load on a specific cross-section over the range of conditions it is expected to endure, commonly known as axle load spectra. To accomplish this, the MEPDG uses a large range of traffic parameters. This level of traffic detail is not commonly available for municipal roadways and some assumptions or regional defaults are necessary.

2.1.1 Traffic Volume

The most common traffic input is the number of vehicles expected to pass over a roadway during its design life. As the load applied by passenger vehicles is very low, the MEPDG does not consider them in the analysis. The number of load applications from trucks and buses is summarized using the Average Annual Daily Truck Traffic (AADTT). For the purpose of providing equivalent designs a range of AADTT values are used ranging from 250 to 10,000 trucks per day. These traffic levels represent collector, minor arterial and major arterial roadways.

For the purposes of this analysis, it is assumed that half of the traffic travels are in each direction. Collector and minor arterial roadways are assumed to have only one lane in each direction, while major arterial roadways are assumed to have two lanes in each direction, with 80 percent of the commercial vehicle traffic in the design lane. A compound growth rate of 2 percent was used to account for increases in vehicle volume over time.

2.1.2 Truck Type Distribution

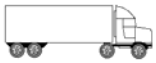
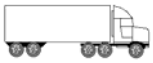
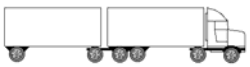
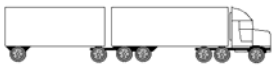
The MEPDG uses a rigorous process to estimate the traffic loads on a roadway. To complete this part of the process, the traffic volume for each month, is divided into the 13 vehicle classes as established by the US Federal Highway Administration (FHWA). Light vehicles, class 1 through 3 (motorcycles and light passenger vehicles), are ignored with the remaining vehicle classes being the focus of the pavement structural design.

The types of vehicles that travel a roadway are typically dependent on the functional classification, the location, and the proximity to industry and natural resources. While conditions may vary locally, typical distributions for the three functional classifications being modelled are shown in Table 2.1.

The commercial vehicle distributions are used in conjunction with axle type and load distributions for Québec. The default values for the following list of parameters were used to represent province of Québec municipal conditions:

- Hourly vehicle distribution
- Monthly vehicle distribution
- Vehicle length and axle spacing

Table 2.1 Expected Commercial Vehicle Distribution for Municipal Roadways

FHWA Class	Commercial Vehicle		Distribution of Commercial Vehicles		
			Collector	Minor Arterial	Major Arterial
4		Two or Three Axle Buses	2.9 %	3.3 %	1.8 %
5		Two-Axle, Six-Tire, Single Unit Trucks	56.9 %	34.0 %	24.6 %
6		Three-Axle Single Unit Trucks	10.4 %	11.7 %	7.6 %
7		Four or More Axle Single Unit Trucks	3.7 %	1.6 %	0.5 %
8		Four or Less Axle Single Trailer Trucks	9.2 %	9.9 %	5 %
9		Five-Axle Single Trailer Trucks	15.3 %	36.2 %	31.3 %
10		Six or More Axle Single Trailer Trucks	0.6 %	1.0 %	9.8 %
11		Five or Less Axle Multi-Trailer Trucks	0.3 %	1.8 %	0.8 %
12		Six-Axle Multi-Trailer Trucks	0.4 %	0.2 %	3.3 %
13		Seven or More Axle Multi-Trailer Trucks	0.3 %	0.3 %	15.3 %

2.2 Climate Condition

A significant factor influencing the performance of pavements is climate. Two major climate regions, Québec City north of St. Lawrence River and Pierre Elliot Trudeau International Airport in Montréal, were selected for this study. Extreme temperatures located in other locations are often accounted for by adjusting materials such as the asphalt binder type, base and sub base. The annual climate statistics of the two regions are shown in Table 2.2.

Table 2.2 Annual Climate Statistics of Two Major Climate Regions of Québec

Parameters	Québec City	Montréal
Mean annual air temperature (°C)	4.49	6.51
Mean annual precipitation (mm)	1181	929
Freezing index (°C - days)	1154	944
Average annual number of freeze/thaw cycles	60	58

2.3 Pavement Materials

The other major advancement in using mechanistic pavement models is the ability to better describe the pavement materials and any changes in their behaviour throughout the year, and over their expected service life. With the climate data available, the effects of temperature on pavement materials can be accounted for, as well as the effects of drainage and freezing.

2.3.1 Portland Cement Concrete

PCC used across Québec is primarily based on (Transports Québec, 2011) with the following exceptions. All non-structurally reinforced concrete exposed to chlorides and freezing & thawing is 35 MPa, Class C-2, with Air Category 1 (varying depending on aggregate size used) with maximum water to cementing materials ratio (W/CM) of 0.45 (as per Tome VII Norme 3101). Based on the minimum specifications, the concrete properties in Table 2.3 were used in the analysis.

Table 2.3 Portland Cement Concrete Properties

Property	Value
Concrete Strength	35 MPa - 28-day Compressive Strength 4.5 MPa - 28-day Modulus of Rupture 29.6 GPa - 28-day Elastic Modulus
Binder types	GU
Unit Weight	2,350 kg/m^3
CSA Exposure Class	C-2
Water to cementing materials Ratio	0.45
Air content	5% to 8%
Maximum slump	40 mm

Concrete pavements in collector are not dowelled. Concrete pavements of thickness less than 200 mm are dowelled in this analysis with 25.4 mm dowel bars and 28.6 mm dowel bars are used for concrete pavement of thickness between 210 mm to 230 mm. Dowels bars are placed at 300 mm intervals across the transverse joints. The slabs length for collector roads, minor and major arterial roads is 4.5 m in length. Collector, minor arterial and major arterial (2,500 and 5,000 AADTT) roads have a tied concrete shoulder/curb on the outside of the pavement, whereas major arterial roads (7,500 and 10,000 AADTT) have a widened slab on the outside lane. For urban sections, a tied concrete curb or a monolithic slab and curb can be used as a tied shoulder or widened slab respectively. All roads are constructed with concrete using Type GU Portland cement, and cured with a white pigmented curing compound.

2.3.2 Hot Mix Asphalt (HMA)

The HMA used for municipal roadways in Québec is primarily based on the MTQ's specification Tome VII - Matériaux (MTQ 2011). This specification provides guidance on the mix design and placement of the different types of mixes commonly used for municipal roadways. ESG 10 is the most commonly used mix as a surface course for collector and arterial roadways. And ESG 14 is used for the base course asphalt. The properties of the HMA materials used in the analysis are shown in Table 2.4.

Table 2.4 Hot Mix Asphalt Properties

Property	ESG 10 (Surface Course)	ESG 14 (Base Course)
Asphalt Cement Type	Variable with traffic	Variable with traffic
Unit weight	2,402 kg/m^3	2,402 kg/m^3
Effective Binder Content	12.2 %	11.4 %
Air Voids	4.0 %	4.0 %
Gradation Passing 19 mm	100 %	100 %
Gradation Passing 9.5 mm	96%	75%
Gradation Passing 4.75 mm	53%	44 %
Gradation Passing 75 ?m	7 %	6 %

The HMA used for municipal roadways in Québec is primarily based on the MTQ's specification (Revised June 2012). This specification provides guidance on the asphalt cement type for surface course and base course according to the Québec zoning provision. For the analysis of Québec City PG grade information for "Zone 2" was used whereas, for Montréal, information from "Zone 1" used as shown in Table 2.5.

Table 2.5 PG Grade for Québec and Montréal

City	Bitumen Type	Collector	Minor Arterial	Major Arterial
Québec "Zone 2"	ESG 10 (Surface)	58-34	64-34	64-34
	ESG 14 (Binder)	58-34	58-34	58-34
Montréal "Zone 1"	ESG 10 (Surface)	64-28	70-28	70-28
	ESG 14 (Binder)	58-28	64-34	64-34

2.3.3 Granular Base and Subbase

The most commonly available aggregates used in pavement construction in Québec consist of MG 20 base and MG 112 subbase. These materials, described in (BNQ, 2004), can be both used beneath the flexible and rigid pavement structures (Table 2.6).

Table 2.6 Granular Base and Subbase Properties

Property	Sieve size	MG 20		MG 112	
Aggregate Gradation (min. and max. percent passing)	112 mm	N/A	N/A	100	100
	31.5 mm	100	100	N/A	N/A
	20 mm	90	100	N/A	N/A
	14 mm	68	93	N/A	N/A
	5 mm	35	60	12	100
	1.25 mm	19	38	N/A	N/A
	315 µm	9	17	N/A	N/A
	80 µm	2	7	0	10
Plasticity Index		0		0	
Modulus		250 MPa		200 MPa	
Poisson's Ratio		0.35		0.35	
Coefficient of Lateral Pressure (k_0)		0.5		0.5	

These materials are commonly available and widely used across Québec. For municipal roadways, the use of an open graded drainage layer is not common and has not been included in any of the pavements in this study. It is however assumed that adequate drainage is provided for both flexible and rigid pavement sections.

2.4 Subgrade Materials

The selection of appropriate properties for the subgrade is an important component of any pavement design. For all detailed pavement designs, geotechnical investigations are required to determine specific conditions for the purposes of providing support to the roadway as well as information on the constructability of the pavement. This is an important step for all pavement design projects.

For this project, a more generic pavement design process was used to develop the pavement designs based on typical subgrade materials for Québec. To characterize the sensitivity of this parameter and to describe the range of potential conditions across the province, the subgrade parameters shown in Table 2.7 were used in the analysis.

Table 2.7 Subgrade Properties

Soil Properties	Low Plasticity Clay	Inorganic Silt	Silty Sand
Subgrade Strength Category	Low	Medium	High
Representative Resilient Modulus (annual average)	30 MPa	40 MPa	50 MPa
Equivalent CBR	3	4	5
Soil Classification	CL	ML	SM
Liquid Limit	30	20	8
Plasticity Index	20	5	2

2.5 Recommended Terminal Service Level

When designing a pavement, the performance criteria of terminal serviceability represents the lowest acceptable condition that will be tolerated before rehabilitation is required. The limits selected represent those typical for a municipality for an arterial roadway and are shown in Table 2.8. Traditionally, the performance parameters are set based on the importance of the roadway and other factors such as the design speed. The level of reliability is higher for higher trafficked roadways to reflect the importance of preventing premature failures.

Table 2.8 Design Performance Parameters

General Pavement Limits	
Initial Design Life	30 years
Design Reliability	Collector - 75% Minor Arterial - 80 % Major Arterial - 90% (2,500 to 5,000 AADTT) Major Arterial - 95% (7,500 to 10,000 AADTT)

Flexible Pavement Terminal Serviceability Limits	
Fatigue (Alligator) Cracking	10 %
Thermal (Transverse) Cracking	200 m/km
Rutting	10 mm
International Roughness Index (IRI)	3.0 mm/m
Rigid Pavement Terminal Serviceability Limits	
Cracked Slabs	10 %
Faulting	6 mm
International Roughness Index (IRI)	3.0 mm/m

3. Development of Recommended Pavement Designs

In order to develop pavement designs for both the concrete and asphalt pavements, a defined process was used to assess the structural capacity of various trial cross-sections. Since the pavement designs were established for municipal pavements in the province of Québec, the materials chosen as well as many of the design features were established based on current Transports Québec design standards and common practice.

While Transport Québec has established pavement design procedures to evaluate the structural capacity of pavements for highway applications in Québec (Chaussées II), the pavement designs determined using this design procedure are considered inappropriate for municipal application due to the significant amount of excavation and subgrade replacement required using this design procedure. There are a substantial number of rigid pavements in the City of Montréal, for example, which are more than 50 years old and have shown excellent performance despite having been placed directly over frost susceptible subgrade.

The thickness of the granular and bound surface layers was the primary factor used to satisfy the design requirements. An initial design was selected based on typical municipal cross-sections and then evaluated within the MEPDG. For each trial section, the MEPDG analysis was completed and results were examined to determine when and how the pavement was expected to fail. The results were then used to modify the trial design to either address premature failure due to one or more of the distresses, or to prevent the over-design of a pavement. The cycle was repeated as necessary to obtain appropriate pavement cross-sections for all traffic and subgrade combinations.

The design process was completed for each combination of subgrade, traffic volume, and pavement type. The primary mode of failure for the pavements was not always the same. For low traffic flexible pavements, the most common cause of failure was a reduction in smoothness. For higher traffic flexible pavements however, fatigue cracking was the limiting factor, with some surface defects expected before the end of the 30 year design life.

For rigid pavements, the modes of failure were primarily based on the pavement design features such as slab length and steel properties. The low traffic designs without dowels typically failed due to a reduced joint load-transfer and subsequent faulting of the joints. However with the addition of dowel bars and a widened slab for higher volume designs, the load transfer was substantially improved and smoothness became the critical distress.

The pavement designs presented ensure that they have sufficient structural capacity to accommodate the anticipated design loadings. It should be recognized that environmental effects such as freezing and thawing can significantly impact the performance of the pavement. In areas of highly frost susceptible soils such as very fine sands and silts, consideration should be given to the incorporation of frost mitigation actions. These could include removal and replacement of the frost susceptible soils within the local frost depth with a non-frost susceptible material, deepening ditches, including subdrains to rapidly remove water from the pavement structure and subsoils, installation of frost tapers, stabilization of subgrade soils to reduce permeability or the use of insulation to limit the penetration of frost into the subgrade.

In order to ensure that the results were fair and reasonable, all of the design cross-sections were then reviewed by a panel of design experts. The review was completed to ensure that the cross-sections matched conditions and municipal performance expectations in Québec.

The resulting pavement designs are shown in **Error! Reference source not found.** and **Error! Reference source not found.**. These designs are considered to be typical for municipal pavements across City of Québec and Montréal. It is however important to note that conditions do vary across the province and some adjustments may be necessary to ensure that they are appropriate for local conditions. A detailed pavement design report should be prepared for each project by a qualified engineer.

Table 3.1 Representative Pavement Designs for Québec City

			Average Annual Daily Truck Traffic (AADTT) - 30 Year Pavement Design-Québec City							
			Collector		Minor Arterial		Major Arterial			
			250	500	1,000	1,500	2,500	5,000	7,500	10,000
Subgrade Strength	30 MPa (CBR=3)	PCC	175 mm PCC 150 mm MG 20	185 mm PCC 150 mm MG 20	200 mm PCC 150 mm MG 20	210 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20
		HMA	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 80 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 90 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 110 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 130 mm ESG 14 150 mm MG 20 550 mm MG 112	50 mm ESG 10 150 mm ESG 14 150 mm MG 20 550 mm MG 112	50 mm ESG 10 170 mm ESG 14 150 mm MG 20 600 mm MG 112
	40 MPa (CBR=4)	PCC	175 mm PCC 150 mm MG 20	185 mm PCC 150 mm MG 20	200 mm PCC 150 mm MG 20	210 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20
		HMA	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 80 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 90 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 110 mm ESG 14 150 mm MG 20 400 mm MG 112	50 mm ESG 10 130 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 160 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 170 mm ESG 14 150 mm MG 20 500 mm MG 112
	50 MPa (CBR=5)	PCC	175 mm PCC 150 mm MG 20	185 mm PCC 150 mm MG 20	200 mm PCC 150 mm MG 20	210 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20
		HMA	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 300 mm MG 112	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 300 mm MG 112	50 mm ESG 10 80 mm ESG 14 150 mm MG 20 300 mm MG 112	50 mm ESG 10 90 mm ESG 14 150 mm MG 20 300 mm MG 112	50 mm ESG 10 110 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 140 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 160 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 180 mm ESG 14 150 mm MG 20 500 mm MG 112
Concrete Slab and Joint Properties			No dowels Slab length = 4.5 m Tied shoulder/curb *		25.4 mm Dowel bars, 300 mm spacing Slab length = 4.5 m Tied shoulder/curb *	25.4 mm Dowel bars, 300 mm spacing Slab length = 4.5 m Tied shoulder/curb *	28.6 mm Dowel bars, 300 mm spacing Slab length = 4.5 m Tied shoulder/curb *	28.6 mm Dowel bars, 300 mm spacing Slab length = 4.5 m Tied shoulder/curb *	28.6 mm Dowel bars, 300 mm spacing Slab length = 4.5 m 0.5 m Widened outside slab or integral curb *	

Notes:

- All materials are based on current Transports Québec Specifications
- Subgrade levels are based on three common subgrade materials in Québec.
  - Low Category (30 MPa) - Low Plasticity Clay Subgrade
  - Medium Category (40 MPa) - Low Plasticity Silt Subgrade
  - High Category (50 MPa) – Silty Sand Subgrade

Reliability Levels

- AADTT 250 to 500 - 75%
- AADTT 1,000 to 1,500 - 80%
- AADTT 2,500 to 5,000 - 90%
- AADTT 7,500 to 10,000 - 95%

* For urban sections, a tied concrete curb or a monolithic slab and curb can be used as a tied shoulder or widened slab respectively.

Table 3.2 Representative Pavement Designs for Montréal

			Average Annual Daily Truck Traffic (AADTT) - 30 Year Pavement Design-Montréal							
			Collector		Minor Arterial		Major Arterial			
			250	500	1,000	1,500	2,500	5,000	7,500	10,000
Subgrade Strength	30 MPa (CBR=3)	PCC	175 mm PCC 150 mm MG 20	185 mm PCC 150 mm MG 20	200 mm PCC 150 mm MG 20	210 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20
		HMA	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 80 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 90 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 110 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 130 mm ESG 14 150 mm MG 20 550 mm MG 112	50 mm ESG 10 150 mm ESG 14 150 mm MG 20 550 mm MG 112	50 mm ESG 10 170 mm ESG 14 150 mm MG 20 600 mm MG 112
	40 MPa (CBR=4)	PCC	175 mm PCC 150 mm MG 20	185 mm PCC 150 mm MG 20	200 mm PCC 150 mm MG 20	210 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20
		HMA	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 80 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 90 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 110 mm ESG 14 150 mm MG 20 400 mm MG 112	50 mm ESG 10 130 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 160 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 170 mm ESG 14 150 mm MG 20 500 mm MG 112
	50 MPa (CBR=5)	PCC	175 mm PCC 150 mm MG 20	185 mm PCC 150 mm MG 20	200 mm PCC 150 mm MG 20	210 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20	220 mm PCC 150 mm MG 20	230 mm PCC 150 mm MG 20
		HMA	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 300 mm MG 112	50 mm ESG 10 55 mm ESG 14 150 mm MG 20 300 mm MG 112	50 mm ESG 10 80 mm ESG 14 150 mm MG 20 300 mm MG 112	50 mm ESG 10 90 mm ESG 14 150 mm MG 20 300 mm MG 112	50 mm ESG 10 110 mm ESG 14 150 mm MG 20 350 mm MG 112	50 mm ESG 10 140 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 160 mm ESG 14 150 mm MG 20 450 mm MG 112	50 mm ESG 10 180 mm ESG 14 150 mm MG 20 500 mm MG 112
Concrete Slab and Joint Properties			No dowels Slab length = 4.5 m Tied shoulder/curb *		25.4 mm Dowel bars, 300 mm spacing Slab length = 4.5 m Tied shoulder/curb *	25.4 mm Dowel bars, 300 mm spacing Slab length = 4.5 m Tied shoulder/curb *	28.6 mm Dowel bars, 300 mm spacing Slab length = 4.5 m Tied shoulder/curb *	28.6 mm Dowel bars, 300 mm spacing Slab length = 4.5 m Tied shoulder/curb *	28.6 mm Dowel bars, 300 mm spacing Slab length = 4.5 m 0.5 m Widened outside slab or integral curb *	

Notes:

- All materials are based on current Transports Québec Specifications
- Subgrade levels are based on three common subgrade materials in Québec.
  - Low Category (30 MPa) - Low Plasticity Clay Subgrade
  - Medium Category (40 MPa) - Low Plasticity Silt Subgrade
  - High Category (50 MPa) – Silty Sand Subgrade

Reliability Levels

- AADTT 250 to 500 - 75%
- AADTT 1,000 to 1,500 - 80%
- AADTT 2,500 to 5,000 - 90%
- AADTT 7,500 to 10,000 - 95%

* For urban sections, a tied concrete curb or a monolithic slab and curb can be used as a tied shoulder or widened slab respectively.

4. Life Cycle Pavement Costs

When selecting a pavement alternative, it is important to understand the expected pavement performance and costs for the entire life-cycle of the pavement. The overall costs and value need to be determined over many years to effectively consider the different options in terms of pavement type, design life, and future rehabilitation. Life-cycle cost analysis (LCCA) has been used for many years in the Province of Québec to help make decisions regarding pavement type as well as selecting pavement preservation options.

In a typical LCCA, two or more alternate choices are available for an initial pavement design or cross-section. Based on the initial pavement designs, the expected maintenance and rehabilitation over the design life are then determined and incorporated into a single, inflation adjusted, cost in order to evaluate and compare the different options in a fair and consistent manner.

The pavements designed for this project have an initial design life of 30 years. At the end of the initial service life, some form of rehabilitation, such as a mill and overlay for a flexible pavement, or slab repairs for a rigid pavement, is usually required. An analysis period of 50 years was used for this project to include the initial service life as well as at least one major rehabilitation activity.

The maintenance and rehabilitation plans provided were developed for municipal roadways with speeds between 50 km/h and 80 km/h. The maintenance and rehabilitation plans for provincial highways tend to be more frequent than for municipal roadways due to differences in posted speed and the higher focus on pavement smoothness for the faster moving highways. The recommended municipal maintenance and rehabilitation plans have been established to provide a reasonable level of service throughout the asset life.

4.1 Concrete Pavement Maintenance and Rehabilitation Plans

Concrete pavements are often constructed for their long service life and the reduced level of maintenance expected due to their slower rate of deterioration. Four maintenance and rehabilitation plans for each pavement type have been developed to coincide with the different functional classifications of the roadways. The initial pavement designs were developed based on the three subgrade types shown in Table 2.7.

For the maintenance and rehabilitation of concrete pavements, the most common activities include improving joint performance through resealing, partial depth repairs, and slab replacements with full depth repairs. On higher volume roadways, the smoothness of the roadway has more significance and some surface texturization is recommended to ensure an acceptable performance.

The recommended maintenance and rehabilitation plans are outlined in Table 4.1 through Table 4.4. These plans were developed to provide a consistent level of service in a cost effective manner. The maintenance and rehabilitation quantities provided are for a 1 km length of roadway and will need to be adjusted for different section lengths.

Table 4.1 Rigid Collector Pavement Preservation Plan (AADTT 250-500)

Expected Year	Activity Description	Quantity (per 1 km of road)
12	Reseal joints	10 %
25	Partial depth PCC repair	2 %
25	Full depth PCC repair	5 %
25	Reseal joints	20 %
40	Partial depth PCC repair	5 %
40	Full depth PCC repair	10 %
40	Reseal joints	20 %

Table 4.2 Rigid Minor Arterial Pavement Preservation Plan (AADTT 1,000-1,500)

Expected Year	Activity Description	Quantity (per 1 km of road)
12	Reseal joints	20 %
25	Partial depth PCC repair	5 %
25	Full depth PCC repair	10 %
25	Reseal joints	25 %
40	Partial depth PCC repair	5 %
40	Full depth PCC repair	15 %
40	Reseal joints	25 %

Table 4.3 Rigid Major Arterial Pavement Preservation Plan (AADTT 2,500-5,000)

Expected Year	Activity Description	Quantity (per 1 km of road)
12	Reseal joints	25 %
12	Partial depth PCC repair	2 %
25	Partial depth PCC repair	5 %
25	Full depth PCC repair	10 %
25	Reseal joints	25 %
40	Partial depth PCC repair	5 %
40	Full depth PCC repair	15 %
40	Reseal joints	25 %

Table 4.4 Rigid Major Arterial Pavement Preservation Plan (AADTT 7,500-10,000)

Expected Year	Activity Description	Quantity (per 1 km of road)
12	Reseal joints	25 %
12	Partial depth PCC repair	2 %
25	Partial depth PCC repair	5 %
25	Full depth PCC repair	10 %
25	Reseal joints	50 %
25	Texturize	25 %
40	Partial depth PCC repair	5 %
40	Full depth PCC repair	15 %
40	Reseal joints	50 %
40	Texturize	50 %

4.2 Hot Mix Asphalt Pavement Maintenance and Rehabilitation Plans

Hot mix asphalt pavements have been commonly used by Québec municipalities due to their history of use and experience with maintenance and rehabilitation. HMA pavements typically deteriorate faster than PCC pavements and require a more extensive maintenance schedule to maintain an acceptable level of service.

The recommend maintenance and rehabilitation schedules for HMA pavements are outlined in Table 4.5 through Table 4.8. These plans use a combination of preventative maintenance and rehabilitation to ensure a cost effective preservation plan. The maintenance and rehabilitation quantities provided are for a 1 km length of roadway and will need to be adjusted for different section lengths.

Table 4.5 Flexible Collector Pavement Preservation Plan (AADTT 250-500)

Expected Year	Activity Description	Quantity (per 1 km of road)
10	Rout and seal	250 m
10	Spot repairs, mill 40 mm/patch 40 mm	2 %
20	Mill HMA	40 mm
20	Resurface with ESG 10	40 mm
25	Rout and seal	500 m
30	Spot repairs, mill 40 mm/patch 40 mm	5 %
35	Mill HMA	40 mm
35	Full depth asphalt base repair	5 %
35	Resurface with ESG 10	40 mm
40	Rout and seal	500 m
43	Spot repairs, mill 40 mm/patch 40 mm	5 %
48	Mill HMA	40 mm
48	Resurface with ESG 10	40 mm

Table 4.6 Flexible Minor Arterial Pavement Preservation Plan (AADTT 1,000-1,500)

Expected Year	Activity Description	Quantity (per 1 km of road)
10	Rout and seal	250 m
10	Spot repairs, mill 40 mm/patch 40 mm	2 %
15	Spot repairs, mill 40 mm/patch 40 mm	10 %
20	Mill HMA	40 mm
20	Resurface with ESG 10	40 mm
25	Rout and seal	500 m
30	Spot repairs, mill 40 mm/patch 40 mm	5 %
35	Mill HMA	40 mm
35	Full depth asphalt base repair	10 %
35	Resurface with ESG 10	40 mm
40	Rout and seal	500 m
43	Spot repairs, mill 40 mm/patch 40 mm	5 %
48	Mill HMA	90 mm
48	Resurface with ESG 14	50 mm
48	Resurface with ESG 10	40 mm

Table 4.7 Flexible Major Arterial Pavement Preservation Plan (AADTT 2,500-5,000)

Expected Year	Activity Description	Quantity (per 1 km of road)
5	Rout and seal	200 m
10	Rout and seal	500 m
10	Spot repairs, mill 40 mm/patch 40 mm	5 %
20	Mill HMA	40 mm
20	Resurface with ESG 10	40 mm
25	Rout and seal	1000 m
30	Spot repairs, mill 40 mm/patch 40 mm	10 %
35	Mill HMA	90 mm
35	Resurface with ESG 14	50 mm
35	Resurface with ESG 10	40 mm
40	Rout and seal	1500 m
45	Spot repairs, mill 40 mm/patch 40 mm	10 %
48	Mill HMA	40 mm
48	Full depth asphalt base repair	5 %
48	Resurface with ESG 10	40 mm

Table 4.8 Flexible Major Arterial Pavement Preservation Plan (AADTT 7,500-10,000)

Expected Year	Activity Description	Quantity (per 1 km of road)
8	Rout and seal	200 m
8	Spot repairs, mill 40 mm/patch 40 mm	5 %
13	Rout and seal	1000 m
13	Spot repairs, mill 40 mm/patch 40 mm	15 %
18	Mill HMA	50 mm
18	Full depth asphalt base repair	10 %
18	Resurface with ESG 10	50 mm
23	Rout and seal	500 m
28	Rout and seal	1500 m
28	Spot repairs, mill 40 mm/patch 40 mm	10 %
32	Mill HMA	90 mm
32	Resurface with ESG 14	50 mm
32	Resurface with ESG 10	40 mm
37	Rout and seal	1500 m
40	Spot repairs, mill 40 mm/patch 40 mm	10 %
45	Mill HMA	50 mm
45	Full depth asphalt base repair	10 %
45	Resurface with ESG 10	50 mm
48	Rout and seal	1500 m

4.3 Pavement Construction Unit Costs

To estimate the cost of various items over the life of a pavement, unit costs of various construction tasks are required. These unit costs are then multiplied by the expected quantities required at different times throughout the service life.

In order for the LCCA to be realistic, it is important to have accurate unit costs for the initial construction and the expected maintenance and rehabilitation plans. These unit costs are typically provided in a format that is consistent with the way construction estimates and bids are generated.

Actual unit costs can vary significantly from project to project depending on conditions, specific project requirements, equipment availability, and location of the project. The unit costs used for the LCCA are considered typical for municipal roadways in Southern Québec.

The unit prices used for the LCCA are shown in Table 4.9 and Table 4.10. While these values are considered reasonable at the time of this report, it is important to note that prices will fluctuate with time and can vary dramatically depending on the location and size of the project. Review and updating of these unit costs is a critical component of any evaluation.

Table 4.9 Unit Costs for Initial Pavement Construction

Pavement Layer	Description of Pavement Layer	Unit Cost
HMA	ESG 10, mm (t) 70-28	$135.00
	ESG 10, mm (t) 64-28	$129.00
	ESG 10, mm (t) 64-34	$135.00
	ESG 10, mm (t) 58-34	$132.00
	ESG 14, mm (t) 64-28	$131.00
	ESG 14, mm (t) 64-34	$132.00
	ESG 14, mm (t) 58-34	$129.00
	ESG 14, mm (t) 58-28	$123.00
PCC	175 mm PCC pavement, no dowels (m^2)	$54.75
	185 mm PCC pavement, no dowels (m^2)	$57.25
	200 mm PCC pavement, 25.4 mm dowels (m^2)	$64.00
	210 mm PCC pavement, 25.4 mm dowels (m^2)	$66.50
	220 mm PCC pavement, 28.6 mm dowels (m^2)	$70.00
	230 mm PCC pavement, 28.6 mm dowels (m^2)	$72.50
Base	MG 20, mm (t)	$23.00
Subbase	MG 112, mm (t)	$21.00
Excavation	Earth excavation (m^3)	$30.00
	Rock excavation (m^3)	$60.00
	Hot mix asphalt pavement excavation (m^3)	$40.00
	Concrete pavement excavation(m^3)	$58.00
	Contaminated material excavation(m^3)	$200.00

Table 4.10 Unit Costs for Maintenance and Rehabilitation Activities

Description of Maintenance and Rehabilitation Treatments	Unit Costs
Rout and seal (m)	$5.00
Spot repairs, mill and patch (m^2)	$20.00
Asphalt base repair (m^2)	$40.00
Mill HMA (t)	$10.40
Resurface with ESG 10 (t)	$135.00
Resurface with ESG 14 (t)	$135.00
Reseal joints (m)	$10.00
Partial depth PCC repair (m^2)	$150.00
Full depth PCC repair (m^2)	$125.00
Texturize (m^2)	$10.00

4.4 Excavation Costs

The costs of excavation are not always necessary to include in an LCCA. They are not applicable to many sites where the pavement geometry is adjusted and the final road grade can be adjusted. Depending on the longitudinal profile and the existing grade of new construction projects, the extent of excavation required may be reduced during the geometric design process.

Due to the difference in the material strength, the total thickness required for PCC pavements is less than that of HMA pavements. When a pavement is being placed to match an existing grade, excavation of existing materials is required. For thicker pavement structures this can add cost for more earth movement and for any haulage and disposal of material that cannot be used on site. The excavation costs, where appropriate, can be a substantial project cost. The typical pavement sections provided have been designed to include excavation costs when necessary. The thinner pavement structure required by concrete pavements can make this a definitive cost advantage.

In the case of pavement reconstruction, the grade of the pavement surface is typically maintained and materials must be excavated to a depth where the new cross-section can be placed. Since the vast majority of pavement works completed by municipalities are for existing roadways and not green field construction, it has been assumed that excavation needs to be accounted for and has been included in the examples provided.

4.5 Estimating Life- Cycle Costs

To ensure a fair comparison of different options, life cycle costs are typically evaluated in terms of their Net Present Worth (NPW). The present worth represents the cost of a future activity in terms of today's dollars. The initial costs and on-going costs are then combined to evaluate the total project present worth.

The future costs are discounted to adjust for inflation and interest rates. The discount rate used to adjust the future costs is typically set at an agency level. The current discount rate used by the Province of Québec is 5.0%.

When evaluating the life-cycle cost, it is typically understood that there is a margin of error due to possible differences in quantities, unit costs, and pavement performance over the service life. Comparisons with marginal differences in cost may require further investigation into other factors to determine the optimal pavement type.

An example LCCA for a major arterial roadway (AADTT = 2,500) on the low strength subgrade for Québec City is shown in Table 4.11 through Table 4.14. This example shows the reduced cost of activities due to discounting, as well as the relatively low cost of the maintenance and rehabilitation compared to the initial construction. The comparison of the costs shown in Figure 4.1 illustrates the relative difference between the two pavement types. For this example, the concrete pavement option has a 13 % lower cost over the pavement life-cycle.

The LCCA process has also been followed and cost comparisons have been generated for other conditions. Full costs comparisons have been developed for all combinations of pavement type, traffic level, and subgrade material. Summaries of the LCCA results from Québec and Montréal can be found in Table 4.15 through Table 4.20 along with all results in Appendix B.

Table 4.11 Initial Pavement Structure Major Arterial Concrete Pavement Québec

Pavement Layer	Description of Pavement Layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6 mm dowels (m^2)	220	15000	$70	$1,050,000
Base	MG 20, mm (t)	150	5063	$23	$116,438
Excavation	Earth excavation mm (m^3)	370	5550	$30	$166,500
Total Initial Cost					$1,332,938

Table 4.12 Pavement Maintenance and Rehabilitation Action Plan Major Arterial Concrete Pavement Québec

Years after initial construction	Description of pavement activity, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$150.00	$45,000	$25,058
12	Reseal joints, % Length (m)	25	833	$10.00	$8,333	$4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$150.00	$112,500	$33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$125.00	$187,500	$55,369
25	Reseal joints, % Length (m)	25	833	$10.00	$8,333	$2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$150.00	$112,500	$15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$125.00	$281,250	$39,950
40	Reseal joints, % Length (m)	25	833	$10.00	$8,333	$1,184
50	Residual Value				$134,028	$11,688
Total M&R Cost					$629,722	$166,176

Table 4.13 Initial Pavement Structure Major Arterial Flexible Pavement Québec

Pavement Layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,800	$135	$243,000
Binder	ESG 14, mm (t) 58-34	110	3,960	$129	$510,840
Base	MG 20, mm (t)	150	5,063	$23	$116,438
Subbase	MG 112, mm (t)	450	15,188	$21	$318,938
Excavation	Earth excavation mm (m^3)	760	11,400	$30	$342,000
Total Initial Cost					$1,531,215

Table 4.14 Pavement Maintenance and Rehabilitation Action Plan Major Arterial Flexible Pavement Québec

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$5	$1,000	$784
10	Rout and seal, m/km (m)	500	500	$5	$2,500	$1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m²)	5	750	$20	$15,000	$9,209
20	Mill HMA, mm (t)	40	1440	$10	$14,976	$5,644
20	Resurface with ESG 10, mm (t)	40	1440	$135	$194,400	$73,267
25	Rout and seal, m/km (m)	1000	1000	$5	$5,000	$1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m²)	10	1500	$20	$30,000	$6,941
35	Mill HMA, mm (t)	90	3240	$10	$33,696	$6,109
35	Resurface with ESG 14, mm (t)	50	1800	$135	$243,000	$44,054
35	Resurface with ESG 10, mm (t)	40	1440	$135	$194,400	$35,243
40	Rout and seal, m/km (m)	1500	1500	$5	$7,500	$1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m²)	10	1500	$20	$30,000	$3,339
48	Mill HMA, mm (t)	40	1440	$10	$14,976	$1,440
48	Full depth asphalt base repair, % area (m²)	5	750	$40	$30,000	$2,884
48	Resurface with ESG 10, mm (t)	40	1440	$135	$194,400	$18,690
50	Residual value				$199,480	$17,395
	Total M&R Cost				$571,992	$194,285

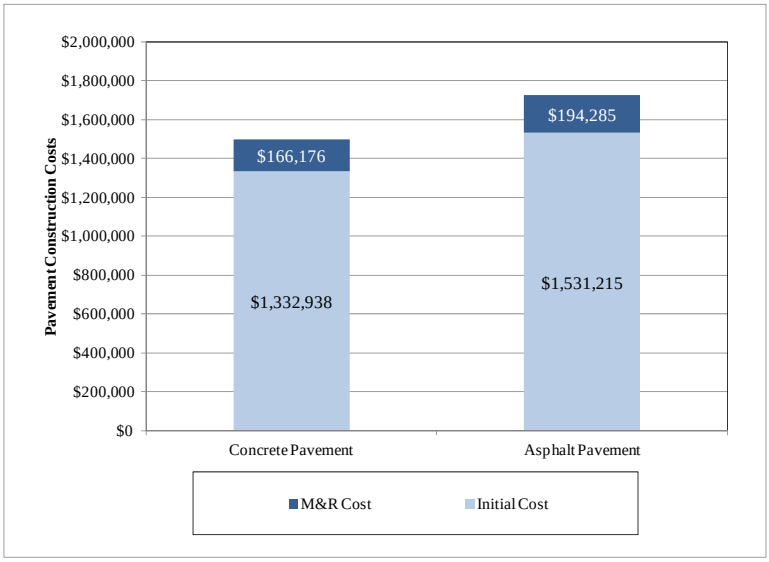


Figure 4.1 Example LCCA Comparison of Costs for a Major Arterial Pavement (AADTT = 2,500)

Table 4.15 Summary of LCCA Results for Low Subgrade Strength- Québec

Typical Municipal Pavement for Québec city

LIFE CYCLE COST ANALYSIS SUMMARY

Listed by 30 Year AADTT and Pavement Type for Low Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 564,885	$ 562,969	$ 567,585
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 634,854	$ 602,691	$ 637,554
LCC Difference	8%		5%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 689,198	$ 637,969	$ 714,668
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 772,173	$ 708,064	$ 796,661
LCC Difference	11%		11%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,531,215	$ 1,374,938	$ 1,748,970
M&R Cost (Discounted)	$ 166,176	$ 194,285	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,725,500	$ 1,541,114	$ 1,943,255
LCC Difference	13%		21%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,974,240	$ 1,466,600	$ 2,144,712
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,299,965	$ 1,668,334	$ 2,470,504
LCC Difference	29%		32%	

Table 4.16 Summary of LCCA Results for Medium Subgrade Strength- Québec

Typical Municipal Pavement for Québec city

LIFE CYCLE COST ANALYSIS SUMMARY

Listed by 30 Year AADTT and Pavement Type for Medium Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 564,885	$ 562,969	$ 564,885
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 634,854	$ 602,691	$ 634,854
LCC Difference	8%		5%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 631,260	$ 637,969	$ 656,730
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 714,236	$ 708,064	$ 738,723
LCC Difference	4%		4%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,473,278	$ 1,374,938	$ 1,633,095
M&R Cost (Discounted)	$ 166,176	$ 198,714	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,671,992	$ 1,541,114	$ 1,827,380
LCC Difference	10%		16%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,904,976	$ 1,466,600	$ 2,021,112
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,230,701	$ 1,668,334	$ 2,346,904
LCC Difference	27%		29%	

Table 4.17 Summary of LCCA Results for High Subgrade Strength- Québec

Typical Municipal Pavement for Québec city
LIFE CYCLE COST ANALYSIS SUMMARY
Listed by 30 Year AADTT and Pavement Type for High Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 535,916	$ 562,969	$ 535,916
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 605,886	$ 602,691	$ 605,886
LCC Difference	4%		1%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 602,291	$ 637,969	$ 627,761
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 685,267	$ 708,064	$ 709,754
LCC Difference	0%		0%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,415,340	$ 1,374,938	$ 1,684,035
M&R Cost (Discounted)	$ 166,176	$ 194,285	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,609,625	$ 1,541,114	$ 1,878,320
LCC Difference	7%		18%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,904,976	$ 1,466,600	$ 2,075,448
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,230,701	$ 1,668,334	$ 2,401,240
LCC Difference	27%		31%	

Table 4.18 Summary of LCCA Results for Low Subgrade Strength- Montréal

Typical Municipal Pavement for City of Montréal

LIFE CYCLE COST ANALYSIS SUMMARY

Listed by 30 Year AADTT and Pavement Type for Low Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 556,245	$ 562,969	$ 556,245
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 626,214	$ 602,691	$ 626,214
LCC Difference	7%		4%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 693,518	$ 637,969	$ 719,528
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 776,493	$ 708,064	$ 801,521
LCC Difference	12%		12%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,543,095	$ 1,374,938	$ 1,763,010
M&R Cost (Discounted)	$ 166,176	$ 194,285	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,737,380	$ 1,541,114	$ 1,957,295
LCC Difference	14%		21%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,991,520	$ 1,466,600	$ 2,164,296
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,317,245	$ 1,668,334	$ 2,490,088
LCC Difference	30%		33%	

Table 4.19 Summary of LCCA Results for Medium Subgrade Strength- Montréal

Typical Municipal Pavement for Québec city

LIFE CYCLE COST ANALYSIS SUMMARY

Listed by 30 Year AADTT and Pavement Type for Medium Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 556,245	$ 562,969	$ 556,245
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 626,214	$ 602,691	$ 626,214
LCC Difference	7%		4%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 635,580	$ 637,969	$ 661,590
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 718,556	$ 708,064	$ 743,583
LCC Difference	4%		5%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,485,158	$ 1,374,938	$ 1,647,135
M&R Cost (Discounted)	$ 166,176	$ 198,714	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,683,872	$ 1,541,114	$ 1,841,420
LCC Difference	11%		16%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,923,408	$ 1,466,600	$ 2,040,696
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,249,133	$ 1,668,334	$ 2,366,488
LCC Difference	28%		30%	

Table 4.20 Summary of LCCA Results for High Subgrade Strength- Montréal

Typical Municipal Pavement for Québec city

LIFE CYCLE COST ANALYSIS SUMMARY

Listed by 30 Year AADTT and Pavement Type for High Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 527,276	$ 562,969	$ 527,276
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 597,246	$ 602,691	$ 597,246
LCC Difference	3%		1%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 606,611	$ 637,969	$ 632,621
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 689,587	$ 708,064	$ 714,614
LCC Difference	0%		1%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,427,220	$ 1,374,938	$ 1,699,155
M&R Cost (Discounted)	$ 166,176	$ 194,285	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,621,505	$ 1,541,114	$ 1,893,440
LCC Difference	8%		19%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,923,408	$ 1,466,600	$ 2,096,184
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,249,133	$ 1,668,334	$ 2,421,976
LCC Difference	28%		31%	

5. Closure

Municipalities are always looking for opportunities to improve the performance of their roadways and more efficiently spend their available budgets. While there are many pavement types available to municipalities, the most common alternatives have historically been asphalt and concrete pavements. Both of these pavement types have been used throughout Québec.

The MEPDG process has many advantages over historic pavement design procedures. More robust design inputs have led to improvements in the design of both asphalt and concrete pavements based on long term pavement performance. The designs developed will meet the needs of municipalities. These designs have been evaluated to ensure that they are consistent with municipal practices across Québec.

Pavement type selection is one of the more challenging engineering decisions facing roadway administrators. The process includes a variety of engineering factors such as materials and structural performance which must be weighed against the initial and life-cycle costs, as well as, sustainable benefits. The technical part of the evaluation includes an analysis of pavement life-cycle strategies including initial and future costs for construction and maintenance, supplemental costs for engineering and contract administration and traffic control/protection and societal costs such as user delay and environmental impact. Non-economic factors such as roadway geometry, availability of local materials, qualified contractors and construction experience, conservation of materials/energy, stimulation of competition, impact on winter maintenance, light reflectance, safety and comfort can also be factored into the decision process. The evaluation helps to select an alternative that is consistent with the agency's financial goals, policy decisions, and experience.

The pavement design and life-cycle cost analysis presented in this report is considered to be typical for Southern Québec municipal pavements. While every attempt has been made to ensure that both PCC and asphalt pavements were treated equally, it should be recognized that specific local factors such as project timing and local experience will often influence the choice of a particular pavement type.

The decision to use life-cycle cost analysis and evaluate sustainable benefits including non-economic factors as part of the pavement type selection process provides government agencies with better knowledge of the true cost of a roadway rather than just considering the initial cost of the pavement. As this report shows, concrete pavements can offer both attractive initial construction costs and favourable life cycle costs when compared to asphalt.

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Appendix A

City of Québec and Montréal Roadway Design Matrix

Typical Pavement Designs for Québec city

			Average Annual Daily Truck Traffic (AADTT) - 30 Year Pavement Design							
			Collector		Minor Arterial		Major Arterial			
			250	500	1,000	1,500	2,500	5,000	7,500	10,000
Subgrade Strength	30 MPa (CBR=3)	PCC	175 mm PCC	185 mm PCC	200 mm PCC	210 mm PCC	220 mm PCC	230 mm PCC	220 mm PCC	230 mm PCC
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
		HMA	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10
			55 mm ESG 14	55 mm ESG 14	80 mm ESG 14	90 mm ESG 14	110 mm ESG 14	130 mm ESG 14	150 mm ESG 14	170 mm ESG 14
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
			350 mm MG 112	350 mm MG 112	450 mm MG 112	450 mm MG 112	450 mm MG 112	550 mm MG 112	550 mm MG 112	600 mm MG 112
	40 MPa (CBR=4)	PCC	175 mm PCC	185 mm PCC	200 mm PCC	210 mm PCC	220 mm PCC	230 mm PCC	220 mm PCC	230 mm PCC
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
		HMA	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10
			55 mm ESG 14	55 mm ESG 14	80 mm ESG 14	90 mm ESG 14	110 mm ESG 14	130 mm ESG 14	160 mm ESG 14	170 mm ESG 14
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
			350 mm MG 112	350 mm MG 112	350 mm MG 112	350 mm MG 112	400 mm MG 112	450 mm MG 112	450 mm MG 112	500 mm MG 112
	50 MPa (CBR=5)	PCC	175 mm PCC	185 mm PCC	200 mm PCC	210 mm PCC	220 mm PCC	230 mm PCC	220 mm PCC	230 mm PCC
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
		HMA	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10
			55 mm ESG 14	55 mm ESG 14	80 mm ESG 14	90 mm ESG 14	110 mm ESG 14	140 mm ESG 14	160 mm ESG 14	180 mm ESG 14
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
			300 mm MG 112	300 mm MG 112	300 mm MG 112	300 mm MG 112	350 mm MG 112	450 mm MG 112	450 mm MG 112	500 mm MG 112
			No Dowels	No Dowels	25.4 mm Dowels	25.4 mm Dowels	28.6 mm Dowels	28.6 mm Dowels	28.6 mm Dowels	28.6 mm Dowels
			4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length
			Tied Shoulder/Curb	Tied Shoulder/Curb	Tied Shoulder/Curb	Tied Shoulder/Curb	Tied Shoulder/Curb	Tied Shoulder/Curb	0.5 m Widened Slab	0.5 m Widened Slab

Notes:

- All materials are based on current Transports Québec Specifications
- Subgrade levels are based on three common subgrade materials in Québec.
  - Low Strength (30 MPa) - Low Plasticity Clay Subgrade
  - Medium Strength (40 MPa) - Low Plasticity Silt Subgrade
  - High Strength (50 MPa) - Sandy Silt Subgrade
- For urban sections, a tied concrete curb or a monolithic slab and curb can be used as a tied shoulder or widened slab respectively.

Typical Pavement Designs for Montreal

			Average Annual Daily Truck Traffic (AADTT) - 30 Year Pavement Design							
			Collector		Minor Arterial		Major Arterial			
			250	500	1,000	1,500	2,500	5,000	7,500	10,000
Subgrade Strength	30 MPa (CBR=3)	PCC	175 mm PCC	185 mm PCC	200 mm PCC	210 mm PCC	220 mm PCC	230 mm PCC	220 mm PCC	230 mm PCC
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
		HMA	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10
			55 mm ESG 14	55 mm ESG 14	80 mm ESG 14	90 mm ESG 14	110 mm ESG 14	130 mm ESG 14	150 mm ESG 14	170 mm ESG 14
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
			350 mm MG 112	350 mm MG 112	450 mm MG 112	450 mm MG 112	450 mm MG 112	550 mm MG 112	550 mm MG 112	600 mm MG 112
	40 MPa (CBR=4)	PCC	175 mm PCC	185 mm PCC	200 mm PCC	210 mm PCC	220 mm PCC	230 mm PCC	220 mm PCC	230 mm PCC
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
		HMA	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10
			55 mm ESG 14	55 mm ESG 14	80 mm ESG 14	90 mm ESG 14	110 mm ESG 14	130 mm ESG 14	160 mm ESG 14	170 mm ESG 14
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
			350 mm MG 112	350 mm MG 112	350 mm MG 112	350 mm MG 112	400 mm MG 112	450 mm MG 112	450 mm MG 112	500 mm MG 112
	50 MPa (CBR=5)	PCC	175 mm PCC	185 mm PCC	200 mm PCC	210 mm PCC	220 mm PCC	230 mm PCC	220 mm PCC	230 mm PCC
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
		HMA	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10	50 mm ESG 10
			55 mm ESG 14	55 mm ESG 14	80 mm ESG 14	90 mm ESG 14	110 mm ESG 14	140 mm ESG 14	160 mm ESG 14	180 mm ESG 14
			150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20	150 mm MG 20
			300 mm MG 112	300 mm MG 112	300 mm MG 112	300 mm MG 112	350 mm MG 112	450 mm MG 112	450 mm MG 112	500 mm MG 112
			No Dowels	No Dowels	25.4 mm Dowels	25.4 mm Dowels	28.6 mm Dowels	28.6 mm Dowels	28.6 mm Dowels	28.6 mm Dowels
			4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length	4.5 m Slab Length
			Tied Shoulder/Curb	Tied Shoulder/Curb	Tied Shoulder/Curb	Tied Shoulder/Curb	Tied Shoulder/Curb	Tied Shoulder/Curb	0.5 m Widened Slab	0.5 m Widened Slab

Notes:

- All materials are based on current Transports Québec Specifications
- Subgrade levels are based on three common subgrade materials in Québec.
  - Low Strength (30 MPa) - Low Plasticity Clay Subgrade
  - Medium Strength (40 MPa) - Low Plasticity Silt Subgrade
  - High Strength (50 MPa) - Sandy Silt Subgrade
- For urban sections, a tied concrete curb or a monolithic slab and curb can be used as a tied shoulder or widened slab respectively.

Appendix B

Life-Cycle Cost Analysis Results

Typical Municipal Pavement for Québec city

LIFE CYCLE COST ANALYSIS SUMMARY

Listed by 30 Year AADTT and Pavement Type for Low Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 564,885	$ 562,969	$ 567,585
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 634,854	$ 602,691	$ 637,554
LCC Difference	8%		5%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 689,198	$ 637,969	$ 714,668
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 772,173	$ 708,064	$ 796,661
LCC Difference	11%		11%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,531,215	$ 1,374,938	$ 1,748,970
M&R Cost (Discounted)	$ 166,176	$ 194,285	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,725,500	$ 1,541,114	$ 1,943,255
LCC Difference	13%		21%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,974,240	$ 1,466,600	$ 2,144,712
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,299,965	$ 1,668,334	$ 2,470,504
LCC Difference	29%		32%	

Road Class	Municipal Collector PCC
AADTT	250
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
175	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	175 mm PCC pavement, no dowels (m²)	175	7500	$ 54.75	$ 410,625
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m³)	325	2438	$ 30.00	$ 73,125
	Total Initial Cost				$ 541,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m²)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m²)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m²)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m²)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class	Municipal Collector HMA
AADTT	250
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 58-34	50	900	$ 132.00	$ 118,800
Binder	ESG 14, mm (t) 58-34	55	990	$ 129.00	$ 127,710
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	605	4,538	$ 30.00	$ 136,125
	Total Initial Cost				$ 564,885

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class	Municipal Collector PCC
AADTT	500
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
185	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section, m	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	185 mm PCC pavement, no dowels (m²)	185	7500	$ 57.25	$ 429,375
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m³)	335	2513	$ 30.00	$ 75,375
	Total Initial Cost				$ 562,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m²)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m²)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m²)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m²)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class	Municipal Collector HMA
AADTT	500
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 58-34	55	990	$ 129.00	$ 127,710
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	605	4,538	$ 30.00	$ 136,125
	Total Initial Cost				$ 567,585

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class	Municipal Minor Arterial PCC
AADTT	1000
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
200	mm PCC
150	mm MG 20
25.4	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	200 mm PCC pavement, 25.4mm dowels (m²)	200	7500	$ 64.00	$ 480,000
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m³)	350	2625	$ 30.00	$ 78,750
	Total Initial Cost				$ 616,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m²)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m²)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m²)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m²)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class	Municipal Minor Arterial HMA
AADTT	1000
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
80 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 58-34	80	1,440	$ 129.00	$ 185,760
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	450	7,594	$ 21.00	$ 159,469
Excavation	Earth excavation (m^3)	730	5,475	$ 30.00	$ 164,250
	Total Initial Cost				$ 689,198

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
15	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 7,215
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 82,976

Road Class	Municipal Minor Arterial PCC
AADTT	1500
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
210	mm PCC
150	mm MG 20
25.4	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	210 mm PCC pavement, 25.4mm dowels (m^2)	210	7500	$ 66.50	$ 498,750
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	360	2700	$ 30.00	$ 81,000
	Total Initial Cost				$ 637,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class	Municipal Minor Arterial HMA
AADTT	1500
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
90 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 58-34	90	1,620	$ 129.00	$ 208,980
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	450	7,594	$ 21.00	$ 159,469
Excavation	Earth excavation (m^3)	740	5,550	$ 30.00	$ 166,500
	Total Initial Cost				$ 714,668

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
18	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 6,233
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 81,993

Road Class	Municipal Major Arterial PCC
AADTT	2,500
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
220	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	15000	$ 70.00	$ 1,050,000
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	370	5550	$ 30.00	$ 166,500
	Total Initial Cost				$ 1,332,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class	Municipal Major Arterial HMA
AADTT	2,500
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
110 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 58-34	110	3,960	$ 129.00	$ 510,840
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	450	15,188	$ 21.00	$ 318,938
Excavation	Earth excavation (m^3)	760	11,400	$ 30.00	$ 342,000
	Total Initial Cost				$ 1,531,215

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 811,368	$ 194,285

Road Class	Municipal Major Arterial PCC
AADTT	5,000
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	15000	$ 72.50	$ 1,087,500
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	380	5700	$ 30.00	$ 171,000
	Total Initial Cost				$ 1,374,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class	Municipal Major Arterial HMA
AADTT	5,000
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
130 mm ESG 14
150 mm MG 20
550 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 58-34	130	4,680	$ 129.00	$ 603,720
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	550	18,563	$ 21.00	$ 389,813
Excavation	Earth excavation (m^3)	880	13,200	$ 30.00	$ 396,000
	Total Initial Cost				$ 1,748,970

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 811,368	$ 194,285

Road Class	Municipal Major Arterial PCC
AADTT	7,500
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
220	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	16000	$ 70.00	$ 1,120,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	370	5920	$ 30.00	$ 177,600
	Total Initial Cost				$ 1,421,800

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class	Municipal Major Arterial HMA
AADTT	7,500
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
150 mm ESG 14
150 mm MG 20
550 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 58-34	150	5,760	$ 129.00	$ 743,040
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	550	19,800	$ 21.00	$ 415,800
Excavation	Earth excavation (m^3)	900	14,400	$ 30.00	$ 432,000
	Total Initial Cost				$ 1,974,240

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
50	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 654
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,725

Road Class	Municipal Major Arterial PCC
AADTT	10,000
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	16000	$ 72.50	$ 1,160,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	380	6080	$ 30.00	$ 182,400
	Total Initial Cost				$ 1,466,600

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class	Municipal Major Arterial HMA
AADTT	10,000
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
170 mm ESG 14
150 mm MG 20
600 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 58-34	170	6,528	$ 129.00	$ 842,112
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	600	21,600	$ 21.00	$ 453,600
Excavation	Earth excavation (m^3)	970	15,520	$ 30.00	$ 465,600
	Total Initial Cost				$ 2,144,712

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
48	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 721
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,792

Typical Municipal Pavement for Québec city

LIFE CYCLE COST ANALYSIS SUMMARY

Listed by 30 Year AADTT and Pavement Type for Medium Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 564,885	$ 562,969	$ 564,885
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 634,854	$ 602,691	$ 634,854
LCC Difference	8%		5%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 631,260	$ 637,969	$ 656,730
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 714,236	$ 708,064	$ 738,723
LCC Difference	4%		4%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,473,278	$ 1,374,938	$ 1,633,095
M&R Cost (Discounted)	$ 166,176	$ 198,714	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,671,992	$ 1,541,114	$ 1,827,380
LCC Difference	10%		16%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,904,976	$ 1,466,600	$ 2,021,112
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,230,701	$ 1,668,334	$ 2,346,904
LCC Difference	27%		29%	

Road Class	Municipal Collector PCC
AADTT	250
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
175	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	175 mm PCC pavement, no dowels (m^2)	175	7500	$ 54.75	$ 410,625
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	325	2438	$ 30.00	$ 73,125
	Total Initial Cost				$ 541,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m^2)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m^2)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class	Municipal Collector HMA
AADTT	250
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 58-34	50	900	$ 132.00	$ 118,800
Binder	ESG 14, mm (t) 58-34	55	990	$ 129.00	$ 127,710
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	605	4,538	$ 30.00	$ 136,125
	Total Initial Cost				$ 564,885

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class	Municipal Collector PCC
AADTT	500
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
185	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section, m	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	185 mm PCC pavement, no dowels (m^2)	185	7500	$ 57.25	$ 429,375
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	335	2513	$ 30.00	$ 75,375
	Total Initial Cost				$ 562,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m^2)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m^2)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class Municipal Collector HMA
AADTT 500
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 58-34	50	900	$ 132.00	$ 118,800
Binder	ESG 14, mm (t) 58-34	55	990	$ 129.00	$ 127,710
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	605	4,538	$ 30.00	$ 136,125
	Total Initial Cost				$ 564,885

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class	Municipal Minor Arterial PCC
AADTT	1000
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
200	mm PCC
150	mm MG 20
25.4	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	200 mm PCC pavement, 25.4mm dowels (m^2)	200	7500	$ 64.00	$ 480,000
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	350	2625	$ 30.00	$ 78,750
	Total Initial Cost				$ 616,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class	Municipal Minor Arterial HMA
AADTT	1000
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
80 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 58-34	80	1,440	$ 129.00	$ 185,760
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	630	4,725	$ 30.00	$ 141,750
	Total Initial Cost				$ 631,260

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
15	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 7,215
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 82,976

Road Class	Municipal Minor Arterial PCC
AADTT	1500
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
210	mm PCC
150	mm MG 20
25.4	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	210 mm PCC pavement, 25.4mm dowels (m^2)	210	7500	$ 66.50	$ 498,750
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	360	2700	$ 30.00	$ 81,000
	Total Initial Cost				$ 637,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class Municipal Minor Arterial HMA
AADTT 1500
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
90 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 58-34	90	1,620	$ 129.00	$ 208,980
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	640	4,800	$ 30.00	$ 144,000
	Total Initial Cost				$ 656,730

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
18	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 6,233
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 14, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 81,993

Road Class	Municipal Major Arterial PCC
AADTT	2,500
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
220 mm PCC
150 mm MG 20
28.6 mm Dowels
4.5 m Slab Length
Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	15000	$ 70.00	$ 1,050,000
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	370	5550	$ 30.00	$ 166,500
	Total Initial Cost				$ 1,332,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class Municipal Major Arterial HMA
AADTT 2,500
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
110 mm ESG 14
150 mm MG 20
400 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 58-34	110	3,960	$ 129.00	$ 510,840
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	400	13,500	$ 21.00	$ 283,500
Excavation	Earth excavation (m^3)	710	10,650	$ 30.00	$ 319,500
	Total Initial Cost				$ 1,473,278

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	1000	1000	$ 20.00	$ 20,000	$ 5,906
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 826,368	$ 198,714

Road Class	Municipal Major Arterial PCC
AADTT	5,000
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	15000	$ 72.50	$ 1,087,500
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	380	5700	$ 30.00	$ 171,000
	Total Initial Cost				$ 1,374,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class Municipal Major Arterial HMA
AADTT 5,000
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
130 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 58-34	130	4,680	$ 129.00	$ 603,720
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	450	15,188	$ 21.00	$ 318,938
Excavation	Earth excavation (m^3)	780	11,700	$ 30.00	$ 351,000
	Total Initial Cost				$ 1,633,095

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 811,368	$ 194,285

Road Class	Municipal Major Arterial PCC
AADTT	7,500
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
220	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	16000	$ 70.00	$ 1,120,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	370	5920	$ 30.00	$ 177,600
	Total Initial Cost				$ 1,421,800

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class Municipal Major Arterial HMA
AADTT 7,500
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
160 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 58-34	160	6,144	$ 129.00	$ 792,576
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	450	16,200	$ 21.00	$ 340,200
Excavation	Earth excavation (m^3)	810	12,960	$ 30.00	$ 388,800
	Total Initial Cost				$ 1,904,976

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
50	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 654
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,725

Road Class	Municipal Major Arterial PCC
AADTT	10,000
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	16000	$ 72.50	$ 1,160,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	380	6080	$ 30.00	$ 182,400
	Total Initial Cost				$ 1,466,600

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class Municipal Major Arterial HMA
AADTT 10,000
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
170 mm ESG 14
150 mm MG 20
500 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 58-34	170	6,528	$ 129.00	$ 842,112
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	500	18,000	$ 21.00	$ 378,000
Excavation	Earth excavation (m^3)	870	13,920	$ 30.00	$ 417,600
	Total Initial Cost				$ 2,021,112

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
48	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 721
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,792

Typical Municipal Pavement for Québec city
LIFE CYCLE COST ANALYSIS SUMMARY
Listed by 30 Year AADTT and Pavement Type for High Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 535,916	$ 562,969	$ 535,916
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 605,886	$ 602,691	$ 605,886
LCC Difference	4%		1%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 602,291	$ 637,969	$ 627,761
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 685,267	$ 708,064	$ 709,754
LCC Difference	0%		0%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,415,340	$ 1,374,938	$ 1,684,035
M&R Cost (Discounted)	$ 166,176	$ 194,285	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,609,625	$ 1,541,114	$ 1,878,320
LCC Difference	7%		18%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,904,976	$ 1,466,600	$ 2,075,448
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,230,701	$ 1,668,334	$ 2,401,240
LCC Difference	27%		31%	

Road Class Municipal Collector PCC
AADTT 250
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
175	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	175 mm PCC pavement, no dowels (m^2)	175	7500	$ 54.75	$ 410,625
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	325	2438	$ 30.00	$ 73,125
	Total Initial Cost				$ 541,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m^2)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m^2)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class Municipal Collector HMA
AADTT 250
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
300 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 58-34	50	900	$ 132.00	$ 118,800
Binder	ESG 14, mm (t) 58-34	55	990	$ 129.00	$ 127,710
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	300	5,063	$ 21.00	$ 106,313
Excavation	Earth excavation (m^3)	555	4,163	$ 30.00	$ 124,875
	Total Initial Cost				$ 535,916

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class Municipal Collector PCC
AADTT 500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
185	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section, m	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	185 mm PCC pavement, no dowels (m^2)	185	7500	$ 57.25	$ 429,375
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	335	2513	$ 30.00	$ 75,375
	Total Initial Cost				$ 562,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m^2)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m^2)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class Municipal Collector HMA
AADTT 500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
300 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 58-34	50	900	$ 132.00	$ 118,800
Binder	ESG 14, mm (t) 58-34	55	990	$ 129.00	$ 127,710
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	300	5,063	$ 21.00	$ 106,313
Excavation	Earth excavation (m^3)	555	4,163	$ 30.00	$ 124,875
	Total Initial Cost				$ 535,916

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class Municipal Minor Arterial PCC
AADTT 1000
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
200	mm PCC
150	mm MG 20
25.4	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	200 mm PCC pavement, 25.4mm dowels (m^2)	200	7500	$ 64.00	$ 480,000
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	350	2625	$ 30.00	$ 78,750
	Total Initial Cost				$ 616,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class Municipal Minor Arterial HMA
AADTT 1000
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
80 mm ESG 14
150 mm MG 20
300 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 58-34	80	1,440	$ 129.00	$ 185,760
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	300	5,063	$ 21.00	$ 106,313
Excavation	Earth excavation (m^3)	580	4,350	$ 30.00	$ 130,500
	Total Initial Cost				$ 602,291

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
15	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 7,215
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 82,976

Road Class Municipal Minor Arterial PCC
AADTT 1500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
210	mm PCC
150	mm MG 20
25.4	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	210 mm PCC pavement, 25.4mm dowels (m^2)	210	7500	$ 66.50	$ 498,750
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	360	2700	$ 30.00	$ 81,000
	Total Initial Cost				$ 637,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class Municipal Minor Arterial HMA
AADTT 1500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
90 mm ESG 14
150 mm MG 20
300 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 58-34	90	1,620	$ 129.00	$ 208,980
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	300	5,063	$ 21.00	$ 106,313
Excavation	Earth excavation (m^3)	590	4,425	$ 30.00	$ 132,750
	Total Initial Cost				$ 627,761

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
18	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 6,233
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 81,993

Road Class Municipal Major Arterial PCC
AADTT 2,500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
220	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	15000	$ 70.00	$ 1,050,000
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	370	5550	$ 30.00	$ 166,500
	Total Initial Cost				$ 1,332,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class Municipal Major Arterial HMA
AADTT 2,500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
110 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 58-34	110	3,960	$ 129.00	$ 510,840
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	350	11,813	$ 21.00	$ 248,063
Excavation	Earth excavation (m^3)	660	9,900	$ 30.00	$ 297,000
	Total Initial Cost				$ 1,415,340

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 811,368	$ 194,285

Road Class	Municipal Major Arterial PCC
AADTT	5,000
Subgrade	50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	15000	$ 72.50	$ 1,087,500
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	380	5700	$ 30.00	$ 171,000
	Total Initial Cost				$ 1,374,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class Municipal Major Arterial HMA
AADTT 5,000
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
140 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 58-34	140	5,040	$ 129.00	$ 650,160
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	450	15,188	$ 21.00	$ 318,938
Excavation	Earth excavation (m^3)	790	11,850	$ 30.00	$ 355,500
	Total Initial Cost				$ 1,684,035

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 811,368	$ 194,285

Road Class	Municipal Major Arterial PCC
AADTT	7,500
Subgrade	50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
220	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	16000	$ 70.00	$ 1,120,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	370	5920	$ 30.00	$ 177,600
	Total Initial Cost				$ 1,421,800

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class Municipal Major Arterial HMA
AADTT 7,500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
160 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 58-34	160	6,144	$ 129.00	$ 792,576
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	450	16,200	$ 21.00	$ 340,200
Excavation	Earth excavation (m^3)	810	12,960	$ 30.00	$ 388,800
	Total Initial Cost				$ 1,904,976

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
50	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 654
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,725

Road Class	Municipal Major Arterial PCC
AADTT	10,000
Subgrade	50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	16000	$ 72.50	$ 1,160,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	380	6080	$ 30.00	$ 182,400
	Total Initial Cost				$ 1,466,600

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class Municipal Major Arterial HMA
AADTT 10,000
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
180 mm ESG 14
150 mm MG 20
500 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-34	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 58-34	180	6,912	$ 129.00	$ 891,648
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	500	18,000	$ 21.00	$ 378,000
Excavation	Earth excavation (m^3)	880	14,080	$ 30.00	$ 422,400
	Total Initial Cost				$ 2,075,448

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
48	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 721
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,792

Typical Municipal Pavement for City of Montréal

LIFE CYCLE COST ANALYSIS SUMMARY

Listed by 30 Year AADTT and Pavement Type for Low Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 556,245	$ 562,969	$ 556,245
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 626,214	$ 602,691	$ 626,214
LCC Difference	7%		4%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 693,518	$ 637,969	$ 719,528
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 776,493	$ 708,064	$ 801,521
LCC Difference	12%		12%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,543,095	$ 1,374,938	$ 1,763,010
M&R Cost (Discounted)	$ 166,176	$ 194,285	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,737,380	$ 1,541,114	$ 1,957,295
LCC Difference	14%		21%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,991,520	$ 1,466,600	$ 2,164,296
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,317,245	$ 1,668,334	$ 2,490,088
LCC Difference	30%		33%	

Road Class Municipal Collector PCC
AADTT 250
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
175	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	175 mm PCC pavement, no dowels (m^2)	175	7500	$ 54.75	$ 410,625
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	325	2438	$ 30.00	$ 73,125
	Total Initial Cost				$ 541,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m^2)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m^2)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class Municipal Collector HMA
AADTT 250
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-28	50	900	$ 129.00	$ 116,100
Binder	ESG 14, mm (t) 58-28	55	990	$ 123.00	$ 121,770
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	605	4,538	$ 30.00	$ 136,125
	Total Initial Cost				$ 556,245

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class Municipal Collector PCC
AADTT 500
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
185	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section, m	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	185 mm PCC pavement, no dowels (m^2)	185	7500	$ 57.25	$ 429,375
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	335	2513	$ 30.00	$ 75,375
	Total Initial Cost				$ 562,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m^2)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m^2)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class Municipal Collector HMA
AADTT 500
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-28	50	900	$ 129.00	$ 116,100
Binder	ESG 14, mm (t) 58-28	55	990	$ 123.00	$ 121,770
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	605	4,538	$ 30.00	$ 136,125
	Total Initial Cost				$ 556,245

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class Municipal Minor Arterial PCC
AADTT 1000
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
200 mm PCC
150 mm MG 20
25.4 mm Dowels
4.5 m Slab Length
Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	200 mm PCC pavement, 25.4mm dowels (m^2)	200	7500	$ 64.00	$ 480,000
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	350	2625	$ 30.00	$ 78,750
	Total Initial Cost				$ 616,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class Municipal Minor Arterial HMA
AADTT 1000
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
80 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 64-34	80	1,440	$ 132.00	$ 190,080
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	450	7,594	$ 21.00	$ 159,469
Excavation	Earth excavation (m^3)	730	5,475	$ 30.00	$ 164,250
	Total Initial Cost				$ 693,518

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
15	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 7,215
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 82,976

Road Class Municipal Minor Arterial PCC
AADTT 1500
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
210 mm PCC
150 mm MG 20
25.4 mm Dowels
4.5 m Slab Length
Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	210 mm PCC pavement, 25.4mm dowels (m^2)	210	7500	$ 66.50	$ 498,750
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	360	2700	$ 30.00	$ 81,000
	Total Initial Cost				$ 637,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class Municipal Minor Arterial HMA
AADTT 1500
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
90 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 64-34	90	1,620	$ 132.00	$ 213,840
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	450	7,594	$ 21.00	$ 159,469
Excavation	Earth excavation (m^3)	740	5,550	$ 30.00	$ 166,500
	Total Initial Cost				$ 719,528

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
18	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 6,233
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 81,993

Road Class Municipal Major Arterial PCC
AADTT 2,500
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
220	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	15000	$ 70.00	$ 1,050,000
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	370	5550	$ 30.00	$ 166,500
	Total Initial Cost				$ 1,332,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class Municipal Major Arterial HMA
AADTT 2,500
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
110 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 64-34	110	3,960	$ 132.00	$ 522,720
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	450	15,188	$ 21.00	$ 318,938
Excavation	Earth excavation (m^3)	760	11,400	$ 30.00	$ 342,000
	Total Initial Cost				$ 1,543,095

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 811,368	$ 194,285

Road Class	Municipal Major Arterial PCC
AADTT	5,000
Subgrade	30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	15000	$ 72.50	$ 1,087,500
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	380	5700	$ 30.00	$ 171,000
	Total Initial Cost				$ 1,374,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class Municipal Major Arterial HMA
AADTT 5,000
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
130 mm ESG 14
150 mm MG 20
550 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 64-34	130	4,680	$ 132.00	$ 617,760
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	550	18,563	$ 21.00	$ 389,813
Excavation	Earth excavation (m^3)	880	13,200	$ 30.00	$ 396,000
	Total Initial Cost				$ 1,763,010

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 811,368	$ 194,285

Road Class Municipal Major Arterial PCC
AADTT 7,500
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
220	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	16000	$ 70.00	$ 1,120,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	370	5920	$ 30.00	$ 177,600
	Total Initial Cost				$ 1,421,800

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class Municipal Major Arterial HMA
AADTT 7,500
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
150 mm ESG 14
150 mm MG 20
550 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 64-34	150	5,760	$ 132.00	$ 760,320
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	550	19,800	$ 21.00	$ 415,800
Excavation	Earth excavation (m^3)	900	14,400	$ 30.00	$ 432,000
	Total Initial Cost				$ 1,991,520

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
50	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 654
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,140,157	$ 325,725

Road Class Municipal Major Arterial PCC
AADTT 10,000
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	16000	$ 72.50	$ 1,160,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	380	6080	$ 30.00	$ 182,400
	Total Initial Cost				$ 1,466,600

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class Municipal Major Arterial HMA
AADTT 10,000
Subgrade 30 MPa (CBR=3)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
170 mm ESG 14
150 mm MG 20
600 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 64-34	170	6,528	$ 132.00	$ 861,696
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	600	21,600	$ 21.00	$ 453,600
Excavation	Earth excavation (m^3)	970	15,520	$ 30.00	$ 465,600
	Total Initial Cost				$ 2,164,296

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
48	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 721
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,792

Typical Municipal Pavement for Québec city

LIFE CYCLE COST ANALYSIS SUMMARY

Listed by 30 Year AADTT and Pavement Type for Medium Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 556,245	$ 562,969	$ 556,245
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 626,214	$ 602,691	$ 626,214
LCC Difference	7%		4%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 635,580	$ 637,969	$ 661,590
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 718,556	$ 708,064	$ 743,583
LCC Difference	4%		5%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,485,158	$ 1,374,938	$ 1,647,135
M&R Cost (Discounted)	$ 166,176	$ 198,714	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,683,872	$ 1,541,114	$ 1,841,420
LCC Difference	11%		16%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,923,408	$ 1,466,600	$ 2,040,696
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,249,133	$ 1,668,334	$ 2,366,488
LCC Difference	28%		30%	

Road Class Municipal Collector PCC
AADTT 250
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
175	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	175 mm PCC pavement, no dowels (m^2)	175	7500	$ 54.75	$ 410,625
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	325	2438	$ 30.00	$ 73,125
	Total Initial Cost				$ 541,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m^2)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m^2)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class Municipal Collector HMA
AADTT 250
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-28	50	900	$ 129.00	$ 116,100
Binder	ESG 14, mm (t) 58-28	55	990	$ 123.00	$ 121,770
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	605	4,538	$ 30.00	$ 136,125
	Total Initial Cost				$ 556,245

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class	Municipal Collector PCC
AADTT	500
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
185	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section, m	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	185 mm PCC pavement, no dowels (m^2)	185	7500	$ 57.25	$ 429,375
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	335	2513	$ 30.00	$ 75,375
	Total Initial Cost				$ 562,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m^2)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m^2)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class Municipal Collector HMA
AADTT 500
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-28	50	900	$ 129.00	$ 116,100
Binder	ESG 14, mm (t) 58-28	55	990	$ 123.00	$ 121,770
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	605	4,538	$ 30.00	$ 136,125
	Total Initial Cost				$ 556,245

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class	Municipal Minor Arterial PCC
AADTT	1000
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
200	mm PCC
150	mm MG 20
25.4	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	200 mm PCC pavement, 25.4mm dowels (m^2)	200	7500	$ 64.00	$ 480,000
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	350	2625	$ 30.00	$ 78,750
	Total Initial Cost				$ 616,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class Municipal Minor Arterial HMA
AADTT 1000
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
80 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 64-34	80	1,440	$ 132.00	$ 190,080
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	630	4,725	$ 30.00	$ 141,750
	Total Initial Cost				$ 635,580

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
15	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 7,215
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 82,976

Road Class	Municipal Minor Arterial PCC
AADTT	1500
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
210	mm PCC
150	mm MG 20
25.4	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	210 mm PCC pavement, 25.4mm dowels (m^2)	210	7500	$ 66.50	$ 498,750
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	360	2700	$ 30.00	$ 81,000
	Total Initial Cost				$ 637,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class Municipal Minor Arterial HMA
AADTT 1500
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
90 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 64-34	90	1,620	$ 132.00	$ 213,840
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	350	5,906	$ 21.00	$ 124,031
Excavation	Earth excavation (m^3)	640	4,800	$ 30.00	$ 144,000
	Total Initial Cost				$ 661,590

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
18	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 6,233
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 14, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 81,993

Road Class	Municipal Major Arterial PCC
AADTT	2,500
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
220 mm PCC
150 mm MG 20
28.6 mm Dowels
4.5 m Slab Length
Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	15000	$ 70.00	$ 1,050,000
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	370	5550	$ 30.00	$ 166,500
	Total Initial Cost				$ 1,332,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class Municipal Major Arterial HMA
AADTT 2,500
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
110 mm ESG 14
150 mm MG 20
400 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 64-34	110	3,960	$ 132.00	$ 522,720
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	400	13,500	$ 21.00	$ 283,500
Excavation	Earth excavation (m^3)	710	10,650	$ 30.00	$ 319,500
	Total Initial Cost				$ 1,485,158

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	1000	1000	$ 20.00	$ 20,000	$ 5,906
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 826,368	$ 198,714

Road Class	Municipal Major Arterial PCC
AADTT	5,000
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	15000	$ 72.50	$ 1,087,500
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	380	5700	$ 30.00	$ 171,000
	Total Initial Cost				$ 1,374,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class Municipal Major Arterial HMA
AADTT 5,000
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
130 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 64-34	130	4,680	$ 132.00	$ 617,760
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	450	15,188	$ 21.00	$ 318,938
Excavation	Earth excavation (m^3)	780	11,700	$ 30.00	$ 351,000
	Total Initial Cost				$ 1,647,135

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 811,368	$ 194,285

Road Class	Municipal Major Arterial PCC
AADTT	7,500
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
220	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	16000	$ 70.00	$ 1,120,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	370	5920	$ 30.00	$ 177,600
	Total Initial Cost				$ 1,421,800

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class Municipal Major Arterial HMA
AADTT 7,500
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
160 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 64-34	160	6,144	$ 132.00	$ 811,008
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	450	16,200	$ 21.00	$ 340,200
Excavation	Earth excavation (m^3)	810	12,960	$ 30.00	$ 388,800
	Total Initial Cost				$ 1,923,408

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
50	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 654
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,725

Road Class	Municipal Major Arterial PCC
AADTT	10,000
Subgrade	40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	16000	$ 72.50	$ 1,160,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	380	6080	$ 30.00	$ 182,400
	Total Initial Cost				$ 1,466,600

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class Municipal Major Arterial HMA
AADTT 10,000
Subgrade 40 MPa (CBR=4)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
170 mm ESG 14
150 mm MG 20
500 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 64-34	170	6,528	$ 132.00	$ 861,696
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	500	18,000	$ 21.00	$ 378,000
Excavation	Earth excavation (m^3)	870	13,920	$ 30.00	$ 417,600
	Total Initial Cost				$ 2,040,696

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
48	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 721
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,792

Typical Municipal Pavement for Québec city

LIFE CYCLE COST ANALYSIS SUMMARY

Listed by 30 Year AADTT and Pavement Type for High Strength Subgrade

Item	Collector			
	250 PCC	250 HMA	500 PCC	500 HMA
Initial Cost	$ 541,969	$ 527,276	$ 562,969	$ 527,276
M&R Cost (Discounted)	$ 39,722	$ 69,969	$ 39,722	$ 69,969
Total Cost	$ 581,691	$ 597,246	$ 602,691	$ 597,246
LCC Difference	3%		1%	

Item	Minor Arterial			
	1,000 PCC	1,000 HMA	1,500 PCC	1,500 HMA
Initial Cost	$ 616,969	$ 606,611	$ 637,969	$ 632,621
M&R Cost (Discounted)	$ 70,095	$ 82,976	$ 70,095	$ 81,993
Total Cost	$ 687,064	$ 689,587	$ 708,064	$ 714,614
LCC Difference	0%		1%	

Item	Major Arterial			
	2,500 PCC	2,500 HMA	5,000 PCC	5,000 HMA
Initial Cost	$ 1,332,938	$ 1,427,220	$ 1,374,938	$ 1,699,155
M&R Cost (Discounted)	$ 166,176	$ 194,285	$ 166,176	$ 194,285
Total Cost	$ 1,499,114	$ 1,621,505	$ 1,541,114	$ 1,893,440
LCC Difference	8%		19%	

Item	Major Arterial			
	7,500 PCC	7,500 HMA	10,000 PCC	10,000 HMA
Initial Cost	$ 1,421,800	$ 1,923,408	$ 1,466,600	$ 2,096,184
M&R Cost (Discounted)	$ 201,734	$ 325,725	$ 201,734	$ 325,792
Total Cost	$ 1,623,534	$ 2,249,133	$ 1,668,334	$ 2,421,976
LCC Difference	28%		31%	

Road Class Municipal Collector PCC
AADTT 250
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
175	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	175 mm PCC pavement, no dowels (m^2)	175	7500	$ 54.75	$ 410,625
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	325	2438	$ 30.00	$ 73,125
	Total Initial Cost				$ 541,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m^2)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m^2)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class Municipal Collector HMA
AADTT 250
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
300 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-28	50	900	$ 129.00	$ 116,100
Binder	ESG 14, mm (t) 58-28	55	990	$ 123.00	$ 121,770
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	300	5,063	$ 21.00	$ 106,313
Excavation	Earth excavation (m^3)	555	4,163	$ 30.00	$ 124,875
	Total Initial Cost				$ 527,276

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class Municipal Collector PCC
AADTT 500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
185	mm PCC
150	mm MG 20
No	Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section, m	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	185 mm PCC pavement, no dowels (m^2)	185	7500	$ 57.25	$ 429,375
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	335	2513	$ 30.00	$ 75,375
	Total Initial Cost				$ 562,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	10	167	$ 10.00	$ 1,667	$ 928
25	Partial depth PCC repair, % area (m^2)	2	150	$ 150.00	$ 22,500	$ 6,644
25	Full depth PCC repair, % area (m^2)	5	375	$ 125.00	$ 46,875	$ 13,842
25	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 984
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 13,317
40	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 473
50	Residual Value				$ 51,111	$ 4,457
	Total M&R Cost				$ 176,597	$ 39,722

Road Class Municipal Collector HMA
AADTT 500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
55 mm ESG 14
150 mm MG 20
300 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 64-28	50	900	$ 129.00	$ 116,100
Binder	ESG 14, mm (t) 58-28	55	990	$ 123.00	$ 121,770
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	300	5,063	$ 21.00	$ 106,313
Excavation	Earth excavation (m^3)	555	4,163	$ 30.00	$ 124,875
	Total Initial Cost				$ 527,276

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	5	375	$ 40.00	$ 15,000	$ 2,719
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 720
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 87,240	$ 7,608
	Total M&R Cost				$ 266,074	$ 69,969

Road Class Municipal Minor Arterial PCC
AADTT 1000
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
200	mm PCC
150	mm MG 20
25.4	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	200 mm PCC pavement, 25.4mm dowels (m^2)	200	7500	$ 64.00	$ 480,000
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	350	2625	$ 30.00	$ 78,750
	Total Initial Cost				$ 616,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class Municipal Minor Arterial HMA
AADTT 1000
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
80 mm ESG 14
150 mm MG 20
300 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 64-34	80	1,440	$ 132.00	$ 190,080
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	300	5,063	$ 21.00	$ 106,313
Excavation	Earth excavation (m^3)	580	4,350	$ 30.00	$ 130,500
	Total Initial Cost				$ 606,611

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
15	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 7,215
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 82,976

Road Class Municipal Minor Arterial PCC
AADTT 1500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design	
210	mm PCC
150	mm MG 20
25.4	mm Dowels
4.5	m Slab Length
	Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	210 mm PCC pavement, 25.4mm dowels (m^2)	210	7500	$ 66.50	$ 498,750
Base	MG 20, mm (t)	150	2531	$ 23.00	$ 58,219
Excavation	Earth excavation (m^3)	360	2700	$ 30.00	$ 81,000
	Total Initial Cost				$ 637,969

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Reseal joints, % Length (m)	20	333	$ 10.00	$ 3,333	$ 1,856
25	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 16,611
25	Full depth PCC repair, % area (m^2)	10	750	$ 125.00	$ 93,750	$ 27,685
25	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 1,230
40	Partial depth PCC repair, % area (m^2)	5	375	$ 150.00	$ 56,250	$ 7,990
40	Full depth PCC repair, % area (m^2)	15	1125	$ 125.00	$ 140,625	$ 19,975
40	Reseal joints, % Length (m)	25	417	$ 10.00	$ 4,167	$ 592
50	Residual Value				$ 67,014	$ 5,844
	Total M&R Cost				$ 291,528	$ 70,095

Road Class Municipal Minor Arterial HMA
AADTT 1500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 2-lane roadway

Pavement Design
50 mm ESG 10
90 mm ESG 14
150 mm MG 20
300 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	7.5
Total width of paved shoulders, m	N/A
Total width of subject road, m	7.5
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	900	$ 135.00	$ 121,500
Binder	ESG 14, mm (t) 64-34	90	1,620	$ 132.00	$ 213,840
Base	MG 20, mm (t)	150	2,531	$ 23.00	$ 58,219
Subbase	MG 112, mm (t)	300	5,063	$ 21.00	$ 106,313
Excavation	Earth excavation (m^3)	590	4,425	$ 30.00	$ 132,750
	Total Initial Cost				$ 632,621

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
10	Rout and seal, m/km (m)	250	250	$ 5.00	$ 1,250	$ 767
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	2	150	$ 20.00	$ 3,000	$ 1,842
18	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	750	$ 20.00	$ 15,000	$ 6,233
20	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 2,822
20	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 36,634
25	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 738
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 1,735
35	Mill HMA, mm (t)	40	720	$ 10.40	$ 7,488	$ 1,358
35	Full depth asphalt base repair, % area (m^2)	10	750	$ 40.00	$ 30,000	$ 5,439
35	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 17,621
40	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 355
43	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	375	$ 20.00	$ 7,500	$ 920
48	Mill HMA, mm (t)	90	1620	$ 10.40	$ 16,848	$ 1,620
48	Resurface with ESG 14, mm (t)	50	900	$ 135.00	$ 121,500	$ 11,681
48	Resurface with ESG 10, mm (t)	40	720	$ 135.00	$ 97,200	$ 9,345
50	Residual value				$ 196,290	$ 17,117
	Total M&R Cost				$ 317,884	$ 81,993

Road Class Municipal Major Arterial PCC
AADTT 2,500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
220 mm PCC
150 mm MG 20
28.6 mm Dowels
4.5 m Slab Length
Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	15000	$ 70.00	$ 1,050,000
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	370	5550	$ 30.00	$ 166,500
	Total Initial Cost				$ 1,332,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class Municipal Major Arterial HMA
AADTT 2,500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
110 mm ESG 14
150 mm MG 20
350 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 64-34	110	3,960	$ 132.00	$ 522,720
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	350	11,813	$ 21.00	$ 248,063
Excavation	Earth excavation (m^3)	660	9,900	$ 30.00	$ 297,000
	Total Initial Cost				$ 1,427,220

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 811,368	$ 194,285

Road Class Municipal Major Arterial PCC
AADTT 5,000
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
230 mm PCC
150 mm MG 20
28.6 mm Dowels
4.5 m Slab Length
Tied Shoulder/Curb

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road, m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	15000	$ 72.50	$ 1,087,500
Base	MG 20, mm (t)	150	5063	$ 23.00	$ 116,438
Excavation	Earth excavation (m^3)	380	5700	$ 30.00	$ 171,000
	Total Initial Cost				$ 1,374,938

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	300	$ 150.00	$ 45,000	$ 25,058
12	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 4,640
25	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 33,222
25	Full depth PCC repair, % area (m^2)	10	1500	$ 125.00	$ 187,500	$ 55,369
25	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 2,461
40	Partial depth PCC repair, % area (m^2)	5	750	$ 150.00	$ 112,500	$ 15,980
40	Full depth PCC repair, % area (m^2)	15	2250	$ 125.00	$ 281,250	$ 39,950
40	Reseal joints, % Length (m)	25	833	$ 10.00	$ 8,333	$ 1,184
50	Residual Value				$ 134,028	$ 11,688
	Total M&R Cost				$ 629,722	$ 166,176

Road Class Municipal Major Arterial HMA
AADTT 5,000
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
140 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	N/A
Total width of subject road m	15.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,800	$ 135.00	$ 243,000
Binder	ESG 14, mm (t) 64-34	140	5,040	$ 132.00	$ 665,280
Base	MG 20, mm (t)	150	5,063	$ 23.00	$ 116,438
Subbase	MG 112, mm (t)	450	15,188	$ 21.00	$ 318,938
Excavation	Earth excavation (m^3)	790	11,850	$ 30.00	$ 355,500
	Total Initial Cost				$ 1,699,155

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
5	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 784
10	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 1,535
10	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	750	$ 20.00	$ 15,000	$ 9,209
20	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 5,644
20	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 73,267
25	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 1,477
30	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 6,941
35	Mill HMA, mm (t)	90	3240	$ 10.40	$ 33,696	$ 6,109
35	Resurface with ESG 14, mm (t)	50	1800	$ 135.00	$ 243,000	$ 44,054
35	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 35,243
40	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,065
45	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1500	$ 20.00	$ 30,000	$ 3,339
48	Mill HMA, mm (t)	40	1440	$ 10.40	$ 14,976	$ 1,440
48	Full depth asphalt base repair, % area (m^2)	5	750	$ 40.00	$ 30,000	$ 2,884
48	Resurface with ESG 10, mm (t)	40	1440	$ 135.00	$ 194,400	$ 18,690
50	Residual value				$ 199,480	$ 17,395
	Total M&R Cost				$ 811,368	$ 194,285

Road Class	Municipal Major Arterial PCC
AADTT	7,500
Subgrade	50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
220	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	220 mm PCC pavement, 28.6mm dowels (m^2)	220	16000	$ 70.00	$ 1,120,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	370	5920	$ 30.00	$ 177,600
	Total Initial Cost				$ 1,421,800

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class Municipal Major Arterial HMA
AADTT 7,500
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
160 mm ESG 14
150 mm MG 20
450 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 64-34	160	6,144	$ 132.00	$ 811,008
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	450	16,200	$ 21.00	$ 340,200
Excavation	Earth excavation (m^3)	810	12,960	$ 30.00	$ 388,800
	Total Initial Cost				$ 1,923,408

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
50	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 654
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,725

Road Class	Municipal Major Arterial PCC
AADTT	10,000
Subgrade	50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design	
230	mm PCC
150	mm MG 20
28.6	mm Dowels
4.5	m Slab Length
0.5	m Widened Slab

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	230 mm PCC pavement, 28.6mm dowels (m^2)	230	16000	$ 72.50	$ 1,160,000
Base	MG 20, mm (t)	150	5400	$ 23.00	$ 124,200
Excavation	Earth excavation (m^3)	380	6080	$ 30.00	$ 182,400
	Total Initial Cost				$ 1,466,600

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
12	Partial depth PCC repair, % area (m^2)	2	320	$ 150.00	$ 48,000	$ 26,728
12	Reseal joints, % Length (m)	25	889	$ 10.00	$ 8,889	$ 4,950
25	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 35,436
25	Full depth PCC repair, % area (m^2)	10	1600	$ 125.00	$ 200,000	$ 59,061
25	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 5,250
25	Texturize, % area (m^2)	25	4000	$ 10.00	$ 40,000	$ 11,812
40	Partial depth PCC repair, % area (m^2)	5	800	$ 150.00	$ 120,000	$ 17,045
40	Full depth PCC repair, % area (m^2)	15	2400	$ 125.00	$ 300,000	$ 42,614
40	Reseal joints, % Length (m)	50	1778	$ 10.00	$ 17,778	$ 2,525
40	Texturize, % area (m^2)	50	8000	$ 10.00	$ 80,000	$ 11,364
50	Residual Value				$ 172,593	$ 15,051
	Total M&R Cost				$ 779,852	$ 201,734

Road Class Municipal Major Arterial HMA
AADTT 10,000
Subgrade 50 MPa (CBR=5)

All quantities and costs are for one km of 4-lane roadway

Pavement Design
50 mm ESG 10
180 mm ESG 14
150 mm MG 20
500 mm MG 112

Geometric Design	
Design feature	Dimension
Width of the traffic lanes, m	15.0
Total width of paved shoulders, m	1.00
Total width of subject road, m	16.0
Length of section	1000

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	ESG 10, mm (t) 70-28	50	1,920	$ 135.00	$ 259,200
Binder	ESG 14, mm (t) 64-34	180	6,912	$ 132.00	$ 912,384
Base	MG 20, mm (t)	150	5,400	$ 23.00	$ 124,200
Subbase	MG 112, mm (t)	500	18,000	$ 21.00	$ 378,000
Excavation	Earth excavation (m^3)	880	14,080	$ 30.00	$ 422,400
	Total Initial Cost				$ 2,096,184

Urban Pavement Maintenance and Rehabilitation Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity	Price per unit of quantity	Cost	Net present worth
8	Rout and seal, m/km (m)	200	200	$ 5.00	$ 1,000	$ 677
8	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	5	800	$ 20.00	$ 16,000	$ 10,829
13	Rout and seal, m/km (m)	1000	1000	$ 5.00	$ 5,000	$ 2,652
13	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	15	2400	$ 20.00	$ 48,000	$ 25,455
18	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 8,297
18	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 26,593
18	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 107,703
23	Rout and seal, m/km (m)	500	500	$ 5.00	$ 2,500	$ 814
28	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,913
28	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 8,163
32	Mill HMA, mm (t)	90	3456	$ 10.40	$ 35,942	$ 7,543
32	Resurface with ESG 14, mm (t)	50	1920	$ 135.00	$ 259,200	$ 54,397
32	Resurface with ESG 10, mm (t)	40	1536	$ 135.00	$ 207,360	$ 43,518
37	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 1,233
40	Spot repairs, mill 40 mm/patch 40 mm, % area (m^2)	10	1600	$ 20.00	$ 32,000	$ 4,545
45	Mill HMA, mm (t)	50	1920	$ 10.40	$ 19,968	$ 2,222
45	Full depth asphalt base repair, % area (m^2)	10	1600	$ 40.00	$ 64,000	$ 7,123
45	Resurface with ESG 10, mm (t)	50	1920	$ 135.00	$ 259,200	$ 28,848
48	Rout and seal, m/km (m)	1500	1500	$ 5.00	$ 7,500	$ 721
50	Residual value				$ 200,181	$ 17,457
	Total M&R Cost				$ 1,147,657	$ 325,792