Sidewalk Pavement Life-Cycle Cost Comparison Tools

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GLOSSARY OF ABBREVIATIONS

AASHTO - American Association of State Highway and Transportation Officials
ACPA - American Concrete Pavement Association
ASCE - American Society of Civil Engineers
ASTM - American Society for Testing Materials
CAC - Cement Association of Canada
CBR - California Bering Ratio
FHWA - U.S. Federal Highway Administration
HMA - Hot Mix Asphalt
ICP - Interlocking Concrete Pavement
ICPI - Interlocking Concrete Pavement Institute
LCC - Life-Cycle Cost
LCCA - Life-Cycle Cost Analysis
NGSMI - National Guide for Sustainable Municipal Infrastructure
PCC - Portland Cement Concrete

Executive Summary

There are more than 1 million miles of sidewalk in North America. The most common surface material used for sidewalks by municipalities in North America is Portland cement concrete (PCC). While used occasionally in an urban environment, the more common use for asphalt concrete for non-vehicular applications is recreational trails. Enhanced sidewalk treatments including interlocking concrete pavers (ICP), clay bricks and large element paving slabs have been used as a part of urban developments, area improvement projects or neighborhood public realm plans. Some cities such as Boston, Massachusetts and Alexandria, Virginia commonly use clay brick for sidewalk surfaces to maintain the historical "ambiance" of their look and texture. As conventional PCC and ICP are the most commonly used materials for urban sidewalks, this report concentrates on their use.

While sidewalks are considered to be a pavement, they are not typically subjected to a formal pavement structural design. Municipal agencies across North America have developed "typical" thickness designs based on their experience with past performance of sidewalks in their jurisdictions. The sidewalk cross sections selected for analysis are shown below.

Portland Cement Concrete
5 in of plain unreinforced Portland cement concrete
4 in of aggregate base
9 in of excavation

Interlocking Concrete Pavement
3 1/8 in pavers
1 in of bedding sand, metal or plastic edge restraints, nailed into the aggregate base
4 in of aggregate base
8 in of excavation

Life-cycle costing is a technique that quantifies all the costs necessary to construct and maintain a sidewalk over a set analysis period, typically between 30 and 50 years. Future costs are discounted to today's dollars by using a discount rate which accounts for the effects inflation (future value of money) and interest rates (the cost of money) to determine the net present value of future costs. By comparing the total life-cycle cost of two or more sidewalk options, it is possible to make informed decisions on the best alternative for a particular application.

Sidewalk maintenance plans were developed for a 40 year service life based on practices typically used by municipal agencies in North America. Unit cost data was collected from several cities and industry sources. Using this data, the initial construction and maintenance costs were developed. Maintenance costs were translated to present worth costs using an annual discount rate of 4 percent. The results of the life-cycle costs are summarized below.

Summary of Life-Cycle Cost Analysis for Sidewalks (Cost/ft^2)

Sidewalk Type	Initial Cost ($)	Maintenance Cost ($)	Total Present Worth of Costs ($)
Concrete	$ 8.39	$ 3.53	$ 11.91
Pavers	$ 9.44	$ 1.00	$ 10.44
Difference Compared to Concrete	+ 11.2 %	- 248 %	- 14.0 %

The results of the analysis show that while the initial cost of ICP sidewalks is about 14 percent higher, the reduced maintenance costs are substantially less resulting in a lower present worth of costs being about 14 percent less than that of PCC sidewalks.

1. Introduction

There are more than 1.6 million kilometers of sidewalk in North America. It is estimated that 15 to 20 percent need replacement at an estimated cost of $15 billion [1,2]. The importance of sidewalks was recognized in Canada in the National Guide for Sustainable Municipal Infrastructure (NGSMI) project with a publication on Sidewalk Design, Construction and Maintenance [2]. Further, movements towards improving sidewalks for citizens with disabilities is beginning to receive significant focus. In the U.S., the U.S. Access Board encourages mandated sidewalk inventories, condition assessments and compliance with recommendations on potential legislation for public use and accessibility [3]. Several cities have conducted such inventories included surface roughness measurements that define sidewalks accessible by wheelchair users. Such inventories are also done to identify trip hazards because they are one of the most significant liabilities to municipal governments.

The common use and benefits of sidewalks and recreational trails is summarized as follows:

- Improved public safety
    - Enables communities to improve safety including pedestrians, cyclists and motorists
- Environment and health
    - Connections between streets, parking lots and buildings will help to reduce vehicle trips, encourage walking and bicycling and reduce sedentary lifestyles
- Quality of Life
    - Makes community more inviting
    - Fosters resident interaction
    - Improves pedestrian experience
    - More use by aging population
- Economic Benefits
    - Good design encourages business investment
    - Increase in property values
    - Attract new business
- Environmental Benefits
    - Reduce stormwater runoff and improve water quality with permeable systems
    - Improve air quality using titanium dioxide (TiO_2) coatings
    - Reduce heat island effect for pedestrians with light colored surfaces plus near-surface evaporative cooling from permeable systems
    - Reduce noise

The most common surface material used for sidewalks by municipalities in North America is Portland cement concrete (PCC). While used occasionally in an urban environment, the more common use for asphalt concrete for non-vehicular applications is recreational trails. Enhanced sidewalk treatments including interlocking concrete pavers (ICP), clay bricks and large element paving slabs have been used as a part of urban developments, area improvement projects or neighborhood public realm plans. Some cities such as Boston, Massachusetts and Alexandria, Virginia commonly use clay brick for sidewalk surfaces to maintain the historical “ambiance” of their look and texture. As conventional PCC and ICP are the most commonly used materials for urban sidewalks, this report concentrates on their use.

2. Sidewalk Plans and Cross Sections

While sidewalks can be considered to be a pavement, they are not typically subjected to a formal pavement structural design. Municipal agencies across North America have developed “typical” thickness designs based on their experience with past performance of sidewalks in their jurisdictions.

The width of concrete sidewalks ranges from 4 to 6 ft with the typical width being 5 ft. Contraction joints are either sawcut of formed to one quarter the depth of the concrete at intervals between 4 and 6 ft. Most agencies also specify expansion joints including a ½ in. width of bituminous fiber board placed full-depth at intervals of 20 ft. Concrete compressive strengths in the order of 3,000 to 4,500 psi are common. A typical concrete sidewalk is shown in Figure 2-1.

Figure 2-1. Typical Portland Cement Concrete with Contraction and Expansion Joints.

The width of interlocking concrete pavement sidewalks ranges from 4 to 6 ft. with the typical width being 5 ft. The pavers are placed on a bedding sand layer with the joints between the pavers filled with joint sand. The pavers are restrained from transverse movement using edge restraints. The quality of the pavers, bedding and joint sand and recommendations for edge restraints are specified in ICPI Tech Spec series 3, 4, 9 and 19 [4-7]. A typical interlocking concrete pavement sidewalk is shown in Figure 2-2. Cross slopes for PCC and interlocking paver sidewalks are 1 to 2 percent.

Figure 2-2. Typical Interlocking Concrete Pavement.

Typical cross sections for PCC and ICP are as follows:

Portland Cement Concrete

- Plain concrete (unreinforced), 5 in. thickness, increased to 6 to 8 in for commercial and industrial driveways subjected to heavy vehicle traffic.
- Minimum dense graded aggregate base 4 in. thickness for uniform support for the concrete and construction traffic. Some agencies specify an open graded aggregate base as a drainage layer beneath the concrete but this is not common.
- Granular subbase thickness depends on exposure to occasional heavy vehicle traffic and subgrade support.

Interlocking Concrete Pavement

- Interlocking concrete paver (3 1/8 in. thickness) with joint sand. May be reduced to 2 3/8 in. for pedestrian only traffic.
- Bedding sand layer (1 to 1 1/8 in.).
- Edge restraints, metal or plastic nailed into the aggregate base.
- Minimum aggregate base of 4 in. for uniform support for the concrete and construction traffic. Some agencies specify an open graded aggregate base as a drainage layer beneath the concrete but this is not common.
- Granular subbase thickness depends on exposure to occasional heavy vehicle traffic and subgrade support.

3. Life-Cycle Costing

Life-cycle costing (LCC) has become an essential component of any modern infrastructure design. It has long been realized that maintenance and rehabilitation costs, not just the immediate initial construction costs should be considered when evaluating investment alternatives. The Federal Highway Administration (FHWA) [7] describes Life-Cycle Cost Analysis (LCCA) as "an analysis technique that builds on the well-founded principles of economic analysis to evaluate the overall long-term economic efficiency between competing alternative investment options." The comparison of life-cycle costs has become standard to not only compare different sidewalk types, but also evaluate different feasible rehabilitation plans over the service life of a sidewalk.

The service life of a sidewalk is defined as the time between initial construction and the time when the sidewalk reaches a minimum unacceptable level of service. Municipal sidewalks are typically designed for an initial service life of 40 years. Unlike roadways, the ability of a sidewalk to carry loads does not substantially change over its life. Sidewalk distress modes are typically related to cracking, material or system failure, settlements and heaves or other distortions. Most of these distresses are dealt with using maintenance techniques such as localized removal and replacement of concrete slabs or pavers, grinding or slab jacking (concrete), resetting of pavers, repair of edge restraints and replenishment of joint sand (pavers).

Life-cycle costing is a technique that quantifies all the costs necessary to construct and maintain a sidewalk over a set analysis period, typically between 30 and 50 years. Future costs are discounted to today's dollars by using a discount rate which accounts for the effects inflation (future value of money) and interest rates (the cost of money) to determine the net present value of future costs. By comparing the total life-cycle cost of two or more sidewalk options, it is possible to make informed decisions on the best alternative for a particular application.

Life-cycle costing can be used to benchmark potential sidewalk options to determine which is the most cost effective. Traditionally, when performing a life-cycle cost analysis comparing sidewalk surface types, only the capital costs for initial construction and maintenance costs for each of the pavement types are considered.

3.1 Design Sidewalk Cross Section

Initial design and construction costs are typically the largest expense over the life cycle of a sidewalk. The initial designs for the PCC and ICP sidewalks selected for life-cycle costing are shown below.

Portland Cement Concrete
5 in. of plain unreinforced concrete
4 in. dense graded aggregate base
9 in. of excavation

Interlocking Concrete Pavement
3 1/8 in. pavers, 90 degree herringbone pattern with manufactured half stones installed along both edges of the sidewalk (no sawcutting necessary)
1 in. of bedding sand, metal or plastic edge restraints
4 in. of dense graded aggregate base
8 in. of excavation

The cost of excavation has been included in the life-cycle cost to compensate for the fact that the thickness of the alternatives is not the same.

3.2 Initial and Maintenance Costs

Initial costs for the construction of sidewalks were developed from information from the Cities of Nashville, Boston, Denver, Minneapolis as well as other industry sources. The costs are in US dollars and include the actual construction of the infrastructure including excavation, granular base and surfacing. Typical maintenance costs were similarly developed for use in the life-cycle cost analysis. A brief description of the activities related to the maintenance costs is described below.

Concrete Panel Replacement: Typically used to repair slab cracking, material defects such as scaling and ravelling, surface openings, raised or sunken areas and root damage. Erect appropriate barricades to ensure pedestrian safety, sawcut edges of the concrete/panels to be replace, jack hammer, remove and dispose of broken concrete, level base and top up with granular base as necessary and compact, place edge forms, place expansion board material as necessary, pour new concrete, form contraction joints, broom finish surface, cure concrete, remove edge forms, restore landscaping adjacent to the repair (top soil, grass seed, etc.) and remove barricades. Typical equipment required includes, personal protective equipment (PPE) shovel, sledge hammer, axe, pry bar, rake, pick, broom, concrete saw, jackhammer, truck or trailer to remove debris, form boards, stakes, expansion board, plate compactor, Ready Mixed Concrete, steel trowel, jointer tool, screed board, bull float, hand float, broom, edging tool, topsoil and grass seed.

Concrete Edge Grinding: Typically used to remove trip hazards up to 1 in. in height. For a one half in. trip hazard grind full width and 6 in. back from the adjacent slab. For a 1 in. trip hazard grind full width and 12 in. back from the adjacent slab. Ensure slip resistance of the ground surface by roughening the surface with a saw blade or other approved method. Typical equipment needed includes PPE and a masonry grinder.

Slab Jacking: Typically used to level uncracked concrete slabs up to 2 in. height. Typical equipment needed includes PPE, a masonry drill and core bit (capable of drilling at 1 to 2 in. core), vehicle equipped with a grout mixer, grout pump, 6 ft. level, measuring tape or other device to measure that sidewalk is level, stiff concrete to fill the drill hole and broom.

Replace Cracked Pavers: Typically used to replace one or several pavers that have been damaged. Scrape the sand from the joints around the paver to be replaced using a metal putty knife, pry the paver upwards using 2 flat head screw drivers or a custom built paver extraction tool, level the bedding sand layer and add sand (if necessary), place the replacement paver, compact using a small plate compactor, fill the joints with sand and compact again to seat the joint sand and sweep the excess sand from the repair area. Typical equipment needed includes PPE, a vehicle to remove debris, metal putty knife, two flat head screw drivers, replacement pavers, bedding/joint sand, wooden or metal bedding sand screed, plate compactor and a broom.

Reset Pavers: Typically used to address areas which are no longer level due to heave or settlement. Scrape the sand from the joints around a single paver using a metal putty knife, pry the paver upwards using 2 flat head screw drivers or a custom built paver extraction tool, remove and retain surrounding pavers necessary to complete the repair, address any base issues adding additional granular base if necessary, place and screed the new bedding sand such that when placed, the pavers will be 1/16th to 1/8th in. above the adjacent paver surface to account for compaction, compact the pavers using a small plate compactor, fill the joints with sand and compact again to seat the joint sand and sweep the excess sand from the repair area. Typical equipment needed includes PPE, a metal putty knife, two flat head screw drivers, bedding/joint sand, wooden or metal bedding sand screed, plate compactor and a broom.

Joint Sand Replacement: Typically used to maintain interlock between pavers. Typical equipment needed includes PPE, joint sand and a broom.

These costs should be adjusted as necessary for local prices and experience when using the LCCA tools provided for specific projects. Unit costs for the sidewalk construction are provided in Table 3-1. Maintenance costs sidewalks are provided in Table 3-2.

Table 3-1. Initial Sidewalk Construction Unit Costs.

Pavement Layer	Description	Unit Cost ($)
PCC	5 in concrete sidewalk (ft^2)	7.50
ICP	3 1/8 in pavers, 1 in bedding sand, hand placed (ft^2)	8.60
Base	Granular base (ton)	18.00
Excavation	Earth excavation (ft^3)	0.60

Table 3-2. Sidewalk Maintenance Costs.

Maintenance Costs	Unit Cost ($)
Concrete panel replacement (ft^2)	21.00
Concrete edge grinding (each)	30.00
Slab jacking (ft^2)	7.00
Replace cracked pavers (ft^2)	11.60
Reset pavers (ft^2)	2.35
Joint sand replenishment (ft^2)	0.15

3.3 Maintenance Plans

When selecting a sidewalk alternative, it is important to understand the expected performance and costs for the entire life cycle of the sidewalk. The overall costs and value need to be determined over many years to effectively consider the different options in terms of surface type, design life, and future maintenance. In a typical LCCA, two or more alternate choices are available for an initial sidewalk cross-section. Based on the initial designs, the expected maintenance 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. An analysis period of 40 years was used for this project.

3.3.1 Concrete Sidewalk

Concrete sidewalks have been extensively used by municipalities across North America. The recommended maintenance schedule for concrete sidewalks is outlined in Table 3-3. The maintenance quantities provided are for a 500 ft. length for comparison purposes and should be adjusted for the actual project section lengths.

Table 3-3. Concrete Sidewalk Preservation Plan.

Expected Year	Activity Description	Quantity (per 500 ft. length)
10	Slab jacking (ft^2)	50
10	Concrete edge grinding (per 3-5 ft)	5
15	Slab jacking (ft^2)	50
15	Concrete edge grinding (per 3-5 ft)	15
25	Concrete panel replacement (ft^2)	100
25	Slab jacking (ft^2)	100
25	Concrete edge grinding (per 3-5 ft)	15
35	Concrete panel replacement (ft^2)	150
35	Slab jacking (ft^2)	100
35	Concrete edge grinding (per 3-5 ft)	10

Interlocking Concrete Pavement

ICPs have been used for sidewalks by municipalities intermittently across North America. Usage of ICP for municipal sidewalks is typically based on development requirements for a high-quality appearance in specific areas of the city attracting tourist and retail type activities. The recommended maintenance schedule for interlocking concrete sidewalks is outlined in Table 3-4. The maintenance quantities provided are for a 500 ft. length comparison purposes and should be adjusted for the actual project section lengths.

Table 3-4. Interlocking Concrete Preservation Plan.

Expected Year	Activity Description	Quantity (per 500 ft. length)
10	Reset Pavers (ft^2)	5
15	Replace Cracked Pavers (ft^2)	3
15	Joint Sand Replenishment (ft^2)	5
20	Reset Pavers (ft^2)	15
25	Joint Sand Replenishment (ft^2)	15
30	Reset Pavers (ft^2)	15
35	Replace Cracked Pavers (ft^2)	15
35	Joint Sand Replenishment (ft^2)	15

4. Life-Cycle Costs

The key benefit of life-cycle cost analysis is the ability to compare alternative sidewalk surface types with different cross-sections and different maintenance strategies. 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.

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 performance over the service life. Comparisons with marginal differences in cost may require further investigation into other factors to determine the optimal pavement type.

4.1 Calculations of Net Present Value

The costs distributed over the pavement are typically translated into a Net Present Value (NPV). The NPV represents the today's total cost expenditures made in the future. Such expenditures account for the interest minus inflation rate (in percent) expressed as the discount rate. The NPV of all activities each occurring in the future are summed to estimate the total maintenance and rehabilitation cost. This summation of activities is expressed as:

$$Total\ M\&R\ Cost\ = \sum_{i}\left(\frac{(M\&R\ Cost_i)}{(1 + Discount\ Rate)^{Age}}\right)$$

The discount rate typically reflects the social discount rate for public sector projects and is dependent on many factors such as current economic environment, market risk, and many other potential factors. It often reflects the difference between the prevailing (market) loan interest rate and the inflation rate. A typical discount rate used by municipal agencies is in the order of 3 to 5 percent. The initial LCCA analysis has been completed for a discount rate of 4 percent.

4.2 Residual Value

To ensure fair comparison of the alternatives, residual value of any unused maintenance or rehabilitation activity at the end of the analysis period must be included in the LCCA. The residual value is estimated by the straight-line depreciation of the last capital activity cost. The prorated life method is used in the LCCA procedure to calculate the residual value. The recoverable cost is estimated by dividing the remaining life of the last rehabilitation treatment, by the expected life of the treatment.

$$Residual\ Value = M\&R\ Cost\ \left(\frac{Service\ Life - Activity\ Age}{Service\ Life}\right)$$

To determine the residual value, the last major rehabilitation activity is used. Based on the year of implementation of the last rehabilitation, the expected service life (from the Unit Costs table) and the activity cost, a proportion of the initial cost is estimated. This residual value at the end of the design period is then converted (discounted) to a net present value. That net present value is then subtracted from the other costs. In the case of sidewalks, there is typically no major rehabilitation activity except for complete removal and replacement. The condition of sidewalks is typically maintained through the use of targeted periodic maintenance. While the concrete sidewalks could be recycled as aggregate base and the pavers could be removed and salvaged for reuse at the end of their service life, this is not common so for this analysis, it has been assumed there is no residual value for either the concrete or the interlocking concrete pavers.

4.3 Calculation of Life-cycle Cost

The total cost to construct and maintain each design option is the outcome from an LCCA. To accomplish this, the sum of all costs using an equivalent NPV is calculated for each option. The total cost for each option is thus calculated as:

$$LCC = Initial\ Cost + Total\ M\&R\ Cost - Residual\ Value$$

This value for each design option can be compared with other design options to determine which is has the lowest cost over the life of the pavement.

4.4 Comparison of Life-cycle Cost

Life-cycle cost analyses were completed for the initial and maintenance costs for concrete and interlocking concrete paver sidewalks using a 5 ft. width, 500 ft. length and discount rate of 4 percent. The results of the analyses are presented in Table 4-1 for concrete pavement and in Table 4-2 for interlocking concrete pavement.

Table 4-1. LCCA for Concrete Sidewalk.

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per 500 ft. length	Price per unit of quantity	Cost
Surface	5 in Concrete Sidewalk (ft^2)	5	2500	$ 7.50	$ 18,750
Base	Granular Base, mm (tons)	4	61	$ 18.00	$ 1,090
Excavation	Earth excavation (ft^3)	9	1875	$ 0.60	$ 1,125
				Total Initial Cost per 500 ft. Length	**$ 20,965**

Maintenance Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity per 500 ft. length	Price per unit of quantity	Cost	Net present worth
10	Concrete Panel Replacement (ft^2)	50	125.0	$ 21.00	$ 2,625	$ 1,773
10	Concrete Edge Grinding (per 3-5 ft)	5	12.5	$ 30.00	$ 375	$ 253
15	Slab Jacking (ft^2)	50	125.0	$ 7.00	$ 875	$ 486
15	Concrete Edge Grinding (per 3-5 ft)	15	37.5	$ 30.00	$ 1,125	$ 625
25	Concrete Panel Replacement (ft^2)	100	250.0	$ 21.00	$ 5,250	$ 1,969
25	Slab Jacking (ft^2)	100	250.0	$ 7.00	$ 1,750	$ 656
25	Concrete Edge Grinding (per 3-5 ft)	15	37.5	$ 30.00	$ 1,125	$ 422
35	Concrete Panel Replacement (ft^2)	150	375.0	$ 21.00	$ 7,875	$ 1,996
35	Slab Jacking (ft^2)	100	250.0	$ 7.00	$ 1,750	$ 443
35	Concrete Edge Grinding (per 3-5 ft)	10	25.0	$ 30.00	$ 750	$ 190
				Total Maintenance Cost/500 ft. Length	**$ 23,500**	**$ 8,814**

Table 4-2. LCCA for Interlocking Concrete Pavement Sidewalk.

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per 500 ft. length	Price per unit of quantity	Cost
Paver	Paver + 1in mm Bedding Sand and Edge Restraints (plastic or metal fixed to granular base (ft^2)	4.15	2,500	$ 8.60	$ 21,500
Base	Granular Base, mm (t)	4	61	$ 18.00	$ 1,090
Excavation	Earth excavation (m^3)	8.15	20	$ 0.60	$ 12
Total Initial Cost/500 ft. Length					**$ 23,608**

Maintenance Action Plan

Years after initial construction	Description of pavement layer, Amount (Quantity)	Amount	Quantity per 500 ft. length	Price per unit of quantity	Cost	Net present worth
10	Reset Pavers (ft^2)	5	125	$ 2.35	$ 294	$ 198
15	Replace Cracked Pavers (ft^2)	3	75	$ 11.60	$ 870	$ 483
15	Joint Sand Replenishment (ft^2)	5	125	$ 0.15	$ 19	$ 10
20	Reset Pavers (ft^2)	15	375	$ 2.35	$ 881	$ 402
25	Joint Sand Replenishment (ft^2)	15	375	$ 0.15	$ 56	$ 21
30	Reset Pavers (ft^2)	15	375	$ 2.35	$ 881	$ 272
35	Replace Cracked Pavers (ft^2)	15	375	$ 11.60	$ 4,350	$ 1,102
35	Joint Sand Replenishment (ft^2)	15	375	$ 0.15	$ 56	$ 14
Total Maintenance and Rehabilitation Cost/500 ft. Length					**$ 7,408**	**$ 2,504**

The life-cycle cost analyses results have been further summarized in terms of cost per square foot and are compared in Table 4-3 and in Figure 4-1. The total life-cycle cost of the interlocking concrete pavement sidewalk is about 14 percent lower than that of concrete sidewalk.

Table 4-3. Summary of Life-Cycle Cost Analysis for Sidewalks (Cost/ft^2)

Sidewalk Type	Initial Cost ($)	Maintenance Cost ($)	Total Present Worth of Costs ($)
Concrete	$ 8.39	$ 3.53	$ 11.91
Pavers	$ 9.44	$ 1.00	$ 10.44
Difference Compared to Concrete	+ 11.2 %	- 248 %	- 14.0 %

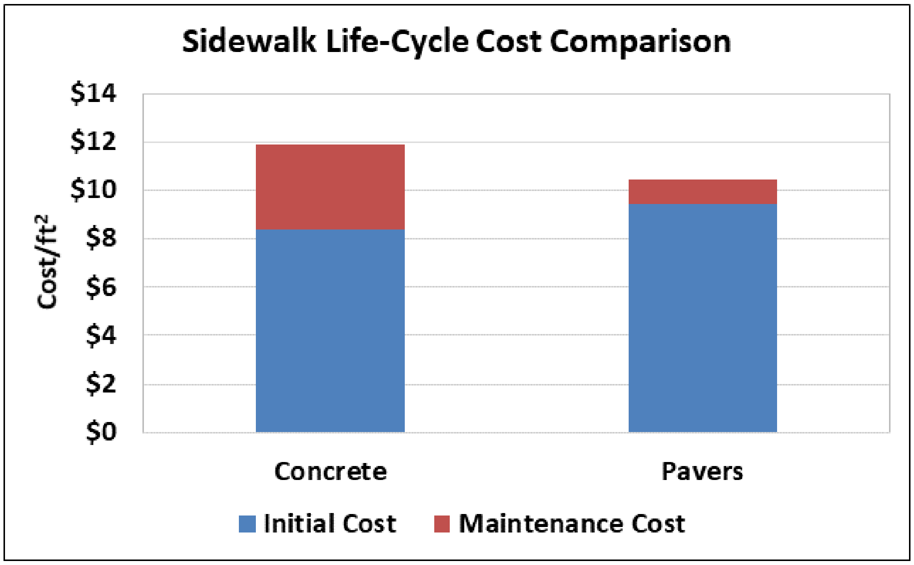

Figure 4-1. Comparison of Sidewalk Life-Cycle Costs

A life-cycle cost spreadsheet template was developed for this project. Modifications can be made to update the frequency and type of maintenance treatments and costs as needed.

5. Conclusions

The most common surface material used for sidewalks by municipalities in North America is Portland cement concrete. Enhanced sidewalk treatments including interlocking concrete pavement and large element paving slabs have been used as a part of urban developments, area improvement projects or neighborhood public realm plans.

The life-cycle cost analysis comparing the initial and future maintenance cost of Portland cement concrete and interlocking concrete pavement showed a 14 percent lower net present worth for the ICP sidewalk. While the initial cost of these enhanced sidewalk treatments is higher than that of concrete, when constructed properly, these types of surfaces can provide a long life with reduced maintenance costs compared to that of conventional concrete. In addition, the visual appeal of the shapes, sizes, laying patterns, colour and texture of interlocking pavement systems can improve the “character” of a neighbourhood or retail area influencing higher property values and retail sales.

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