Interlocking Concrete Pavement Life-cycle Cost Studies

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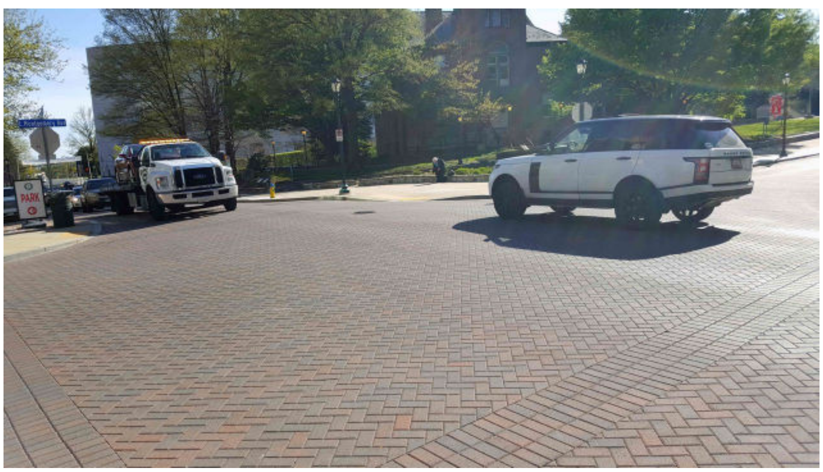
Background and Need

Life cycle cost analysis (LCCA) is a tool for comparing the economic performance of future pavement choices and for evaluating past choices. LCCA for evaluating future pavement costs are often based on a record of past construction and maintenance costs. If few or none exist, then assumptions are made regarding these costs supported by rationale.

LCCA considers initial construction costs plus all maintenance costs expected (or done) between major pavement rehabilitations. Future maintenance costs are discounted to establish their present value (aka present worth) since money spent in the future are worth less than today's money. Called the discount rate, present value is defined as the cost of borrowing money, expressed as an interest rate for borrowing money, minus the rate of inflation. For years, road agencies often use 4% as the discount rate.

The need for this project emerged from a lack of LCCA for interlocking concrete pavements (ICP) for municipal streets as well as software tools to conduct such analyses.



Objectives

The project included the following objectives:

1. Identify barriers and opportunities to more widespread municipal use of ICP via a survey of municipal agencies.
2. Develop LCCA models enabling comparison of ICP to conventional pavement that includes a sensitivity analysis of various discount rates using various traffic loads, subgrade types, and appropriate pavement structures.
3. Develop LCCA models for cuts in pavement to repair utilities (aka 'utility cuts') and for user delays from pavement rehabilitation.
4. Develop LCCA models comparing ICP and concrete sidewalks.

Outcomes

1. The survey included responses from 11 municipal governments in the U.S. and Canada. A summary of the findings:
    - Some municipal agencies use LCCA for pavement type selection. However, the initial cost of ICP compared to conventional asphalt pavement is a difficult to overcome since budgets, equipment and staff are organized around asphalt pavement construction and maintenance costs.

- Municipalities who have successfully implemented ICP in their roadways understand the LCCA benefits. However, barriers to wider adoption are due to the higher initial costs the need for education of operations and maintenance staff to provide timely pavement maintenance.
- When compared to asphalt, awareness of ICP design and LCCA tools, education and training activities is generally very low.

2. All LCCA models and sensitivity analysis were developed using Excel software. Detailed LCCAs for 50 years using a discount rate of 4% resulted in 32 combinations of traffic, soil types, and pavement structures. ICP LCCAs were higher than that of asphalt and concrete roadways. A sensitivity analysis used discount rates of 1% to 5% with a reduction in the unit cost of pavers at 10%, 15% and 20%. This analysis resulted ICP having a lower life-cycle cost or a life-cycle cost within 5% of the cost of asphalt roads for higher traffic roadways on all subgrade strengths using 1% to 3% discount rates. In other words, the LCCA points to the difficulty of justifying ICP on lightly trafficked residential roads unless the developer bears the initial construction cost, dedicates the ICP roads to the municipality. This would result in a substantially lower maintenance cost compared to asphalt. However, ICP on more heavily trafficked roads can be justified via LCCA due to higher asphalt maintenance costs.

3. The LCCA for utility cuts used a discount rate of 4% and analysis period of 50 years. The analysis results demonstrate that asphalt pavement with utility cuts can have an almost 200% higher life-cycle costs than an ICP pavement when both are exposed to utility cuts. Due to its modular nature, a properly completed utility cut repair for an ICP can have little required maintenance and almost no impact on the future performance of the pavement. This can provide a significant LCCA benefit for ICPs. In addition, the use of flowable fill offers an extra measure of long-term stability and risk reduction of settlement should an agency prefer this option.

For the user delay costs, ICP had a slightly lower life cycle costs compared to asphalt. However, the total cost of delays is very small compared to the total pavement life cycle costs. For this analysis, the cost of user delays represented about 1.7% of the present value of maintenance and rehabilitation costs.

4. The LCCA for sidewalks used a 4% discount rate and an analysis period of 40 years. The analysis results show that while the initial cost of ICP sidewalks is about 14% higher and concrete sidewalks with an aggregate base, maintenance costs are substantially lower for ICP, about 14% lower than that for concrete sidewalks.

At the time of the start of this study, asphalt had low initial costs and high maintenance costs. In contrast, correctly designed and installed ICP tends to have a higher initial costs than asphalt but significantly lower maintenance costs. This is particularly true for minor collector roads and those with higher traffic as they require increasingly more maintenance when paved with asphalt due to cracking and rutting. At the time of this writing, asphalt costs have increased significantly due to world events as well as interest rates and inflation. This Excel sheets may require revisiting using more recent costs.

Deliverables included Excel sheets where asphalt and ICP costs can be applied to specific projects. In addition, PowerPoint presentations were provided. Four reports on the above studies can be accessed online:

Interlocking Concrete Pavement Life-Cycle Cost Comparison Tools

Sidewalk Pavement Life-Cycle Cost Comparison Tools

Impact of User Delay on Pavement Life-Cycle Cost

Comparison of Utility Cut Impacts on Pavement Performance