Implementing Sustainability Research Saves Illinois Tollway More Than $200 Million

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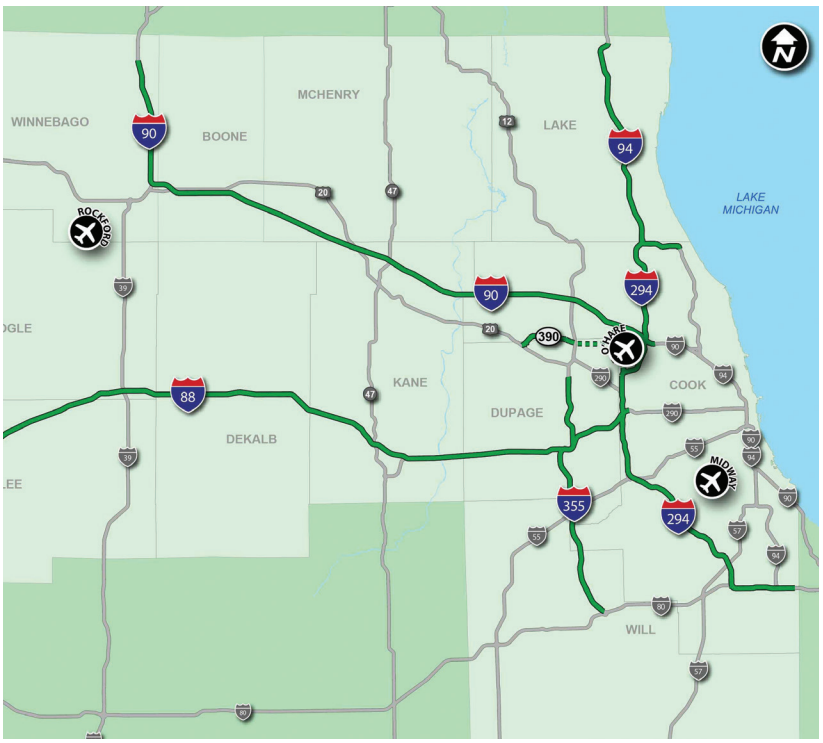
The Illinois Tollway has steadily increased the implementation of research findings over the past 12 years, producing new standards and policies for pavements, materials, and recycling. The tollway recently reviewed the documentation of construction costs and found that the adoption of more innovative and sustainable material specifications saved an estimated $218.5 million between 2004 and the start of 2016. Normalized to 2015 dollar values, the cost savings demonstrate that sustainable recycling of aggregate, asphalt, and concrete materials have yielded substantial economic benefits, in addition to environmental and social benefits.

Aggregates

In 2004, approximately $9 billion of an $18-billion, 25-year capital program were allocated to reconstruct and expand much of the Illinois Tollway (see Figure 1, below). Before then, the tollway did not use cost-efficient methods to reprocess pavements into recycled aggregates, although other agencies had developed and successfully implemented on-site processing techniques and concrete pavement rubblization (*1*).

FIGURE 1 Illinois Tollway system map.



The Illinois Tollway rubblized nearly 32 miles of concrete pavement in place along the Interstate 88 (I-88) extension for reuse as the new base for an asphalt pavement. Compared with the cost of totally reconstructing the mainline roadway, the cost of this strategy saved the tollway approximately $29.5 million. The Illinois Tollway's program management organization, HNTB, confirmed that the remainder of the capital projects saved an estimated $83.5 million through 2015 by recycling all pavements into the new bases of the reconstructed and widened roadways.

Asphalt

After realizing the economic benefits of adopting new initiatives for recycling or improving sustainability through aggregate production, the Illinois Tollway began investigating how similar savings could be achieved with more sustainable asphalt materials without sacrificing performance or durability. Through several consulting engineer contracts, starting in 2006, researchers performed tasks and reported the results; these activities evolved into an Illinois Tollway–sponsored research program in 2009, which established direct agreements with university research teams to produce formal studies (*2*).

Ground Tire Rubber–Modified Asphalt Binder

In 2006, the Illinois Tollway joined a task force initiated by the Cook County Highway Department to field-test high-performance stone matrix asphalt (SMA) mixes with asphalt binder modified at the asphalt terminal to include shredded scrap tires at up to 12 percent of the mix. The mix samples were evaluated for long-term performance.

Results showed that the expected life of SMA mixes modified with ground tire rubber (GTR) would be equivalent to that of the standard polymer-modified SMA mixes used by the Illinois Department of

Transportation (DOT). Moreover, the mixes could be produced without the cellulose fibers needed to minimize the draindown or surface flushing of asphalt binder. Samuel Carpenter of the University of Illinois performed the informal research task.

GTR-modified SMA mixes save an estimated $7.50 per ton by eliminating the need for fiber reinforcement. This equates to a savings of $2.2 million for the 300,000 tons of SMA the Illinois Tollway produced from 2008 to 2011. The two choices for modified asphalt in SMA mixes allow for more competitive bidding on the Illinois Tollway's SMA overlay projects and may reduce bid prices while maintaining product quality.

Fractionated Reclaimed Asphalt Pavement

The Illinois Tollway began investigating fractionated reclaimed asphalt pavement (FRAP) through research at the University of Illinois in 2007. Researchers found that asphalt mixes could contain an average of 15 percent more RAP with fractionation and that the pavement would have the same high performance as RAP mixes used by the tollway and by Illinois DOT (*3*). The increased FRAP reduced the costs of the asphalt mixes by $10 to $15 per ton.

A reconstruction and widening project placed approximately 800,000 tons of high-FRAP asphalt mixes on the Jane Addams Memorial Tollway (I-90–I-39) in 2008 and 2009, with an estimated cost savings of $10 million. These levels of savings have continued after implementing higher quantities of FRAP.

Recycled Asphalt Shingles

In 2009, with the help of a grant from the U.S. Environmental Protection Agency, the Illinois Tollway teamed with Iowa State University and the University of Illinois to study the combination of recycled asphalt shingles (RAS) with high FRAP in shoulder mixes (*4*). The up to 5 percent RAS allowable in asphalt mixes can reduce the need for virgin asphalt binder by approximately 20 percent.

The same year, a project placed polymer-modified SMA mixes that used RAS as a fiber substitute on I-90–I-39, and the University of Illinois conducted performance tests on the pavement (*5*). In 2010, the University of Illinois studied SMA mixes modified with increased FRAP and RAS content and with high levels of asphalt binder replacement, using a variety of warm-mix asphalt processes. The results from all studies confirmed the long-term durability of asphalt mixes with properly processed RAS (*6*).

The Illinois Tollway now permits RAS in all asphalt mixes at levels up to 5 percent. The savings with RAS depend on the asphalt mix but are estimated at $5 to $15 per ton. Approximately 2.6 million tons of asphalt mixes with RAS were produced etween 2010 and 2015, yielding a savings of around $21 million.

Photo: Illinois Tollway

Long windrow of recycled material awaiting reuse on I-88.

The University of Illinois recently completed a study evaluating field core samples of aged SMA mixes from the tollway system. The findings confirmed that high levels of asphalt binder replacement with RAS and FRAP in high-performance SMA mixes do not reduce durability when the by-product materials are properly processed (*7*).

By implementing these asphalt-related initiatives, the Illinois Tollway increased the use of recycled materials and reduced the use of liquid asphalt, virgin aggregates, and fiber reinforcement in all asphalt mix designs without compromising quality. These changes in the asphalt mix designs resulted in savings of $74 million dollars for the tollway from 2007 through 2015.

Concrete

Project R-21 of the second Strategic Highway Research Program produced tools and technologies for composite pavement systems (*8*). Building on these and on research at the University of Illinois, the Illinois Tollway developed specifications for composite two-lift concrete pavement to rebuild the west-end I-90 pavements with higher levels of recycled aggregate and supplementary cementitious materials (SCM) from waste sources (*9, 10*). The two-lift jointed plain concrete pavement (JPCP) on I-90 reduced unit prices significantly, compared with prices for other recent tollway projects that used JPCP. The estimated cost savings for more than 1 million square yards of two-lift JPCP on I-90 in 2013 and 2014 was approximately $23.5 million.

Additional informal research through the laboratories of the CTL Group led to increasing the amounts of SCM in mixes with optimized aggregate gradations; this has improved the sustainability of concrete mixes for standard pavement designs and has reduced bid prices. For the 841,205 square yards of 13-inch JPCP built on I-90 in 2015, the tollway calculated a total savings of approximately $8 million from the new standards and policies.

Looking Ahead

By putting sustainability research into practice, the Illinois Tollway has saved more than $200 million in the past 12 years (see Table 1, above right) and expects to save hundreds of millions of dollars more. Ongoing initiatives include warm-mix asphalt for most Illinois Tollway asphalt mixes, the development and application of precast concrete pavements and durable high-early-strength concrete patching mixes, the reengineering of the design for continuously reinforced concrete pavements, and the development of standards and policies for accelerated bridge construction. These initiatives do not have large up-front cost savings but are expected to yield substantial life-cycle savings by reducing maintenance needs and extending the service life of bridges and pavements.

TABLE 1 Estimated Cost Savings, by Materials

Applications	Years	Total Cost Savings
Aggregate	2004–2015	$113,000,000
Asphalt	2007–2015	$74,000,000
Concrete	2013–2016	$31,500,000
Total approximate savings		$218,500,000

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Suggestions for Research Pays Off topics are welcome. Contact Stephen Maher, Transportation Research Board, Keck 486, 500 Fifth Street, NW, Washington, DC 20001; 202-334-2955; smaher@nas.edu.