ADDAMS EXPRESSWAY PAVEMENT RECONSTRUCTION —

LIFE-CYCLE COST ANALYSIS

BACKGROUND

In 2012, the Illinois Tollway made the decision to reconstruct and expand capacity along the Jane Addams Memorial Tollway between I-39 and the Kennedy Expressway. The Tollway then performed a life-cycle cost analysis (LCCA) to determine the relative costs of five different pavement types. Costs were calculated for one mile in one direction for initial construction and for the maintenance activities anticipated over a 50-year life span for each of the pavement types under consideration. As traffic levels and the number of lanes varied along the length of the proposed project, three analysis sections were established corresponding to the western, central, and eastern portions of the corridor.

PAVEMENT TYPES

Five different pavement types were considered for the reconstruction of the Addams Tollway, including:

- 2-lift, black rock Jointed Plain Concrete Pavement (JPCP)
- 2-lift, black rock Continuously Reinforced Concrete Pavement (CRCP)
- Full-depth hot-mix asphalt (FDHMA)
- Stone Mastic Asphalt (SMA) over JPCP
- SMA over CRCP

All pavement thickness designs were evaluated using the AASHTO DARWin-ME software. For each of the three traffic levels, final pavement thickness was the minimum structure that would provide 30 years before distress levels exceeded the allowable limits for that specific pavement type. Due to the increase in traffic levels from I-39 to the Kennedy along the Addams, the total required pavement thicknesses increased from west to east.

INITIAL CONSTRUCTION COSTS

For all pavement types in all analysis sections, the first cost included in the LCCA was the removal of the existing pavement. For the western and central sections, this required removal of two existing mainline lanes while the east section required three mainline lanes to be removed. For all sections and all pavement types, costs were then added to account for preparation of the subgrade for the new lane to be constructed in each direction for each section. Costs associated with placing 12 inches of subgrade aggregate were then applied to all sections and all pavement types.

Pavement drainage system costs were added to all sections and all pavement types. The pavement drainage cost was based on a system consisting of a longitudinal 6-in drain pipe running along the inside and outside shoulders of each section, 25 feet of 8-in outlet pipe placed at 50-foot intervals along the inside and outside shoulders transverse to the direction of the pavement, and finally a protective end section for each of the 8-in outlet pipes.

No costs for the construction of FDHMA shoulders were included in the LCCA calculations for any pavement type since all pavement types would incur the same costs (the design of the FDHMA shoulders is the same for all pavement types in all of the analysis sections).

FDHMA

Total pavement thickness for the FDHMA pavement was made up of the following:

- 2 inches of SMA surface course (IL-12.5, N80)
- 2 inches of SMA binder course (IL-12.5, N80)
- 5 to 6 inches of binder course (IL-19.0, N70) depending on the traffic levels
- 3 inches of polymerized binder course (IL-19.0, N90)

JPCP and CRCP

Both JPCP and CRCP pavements included 3 inches of HMA binder course (IL-19.0, N50) under varying PCC thicknesses, depending on the traffic level for the analysis section.

SMA over JPCP

The SMA over JPCP pavement included 3 inches of HMA binder course (IL-19.0, N50) on which the varying thickness of JPCP was placed. The top layer of this pavement type consisted of 2 inches of SMA surface course, which required sawing and sealing of the SMA directly above all of the longitudinal and transverse JPCP joints.

SMA over CRCP

The SMA over CRCP pavement also included 3 inches of HMA binder course (IL-19.0, N50) on which the varying thickness of CRCP was placed.

Indirect Initial Costs

For all of the initial construction costs described above, maintenance of traffic (MOT), Design Section Engineer (DSE), and Construction Section Engineer (CSE) services costs were added to all sections and all pavement types, at 5, 8, and 9 percent of the total direct costs, respectively.

MAINTENANCE COSTS

Based on the performance predicted for each pavement type by the DARWin-ME software, and the incorporation of Tollway experience and historical timing for maintenance operations, a stream of maintenance activities was developed for each of the five pavement types under consideration. The activities and anticipated timing of each are shown for the five pavement types in the following table.

Future Maintenance Activities Included in I-90 LCCA Calculations

Year	Pavement Type				
	2-lift JPCP	2-lift CRCP	FDHMA	SMA/JPCP	SMA/CRCP
8			Crack rout/fill, Class D Patch (2.0%)	Crack rout/fill, Class B Patch (2.0%)	
11	Joint reseal	Class A Patch (0.1%)			Crack rout/fill, Class A Patch (0.1%)
15			Mill, Class D Patch (1.0%), SMA OL	Mill, SMA OL, Joint reseal	
18	Class B Patch (3.5%), Joint reseal				Mill, Class A Patch (1.0%), SMA OL
22				Crack rout/fill, Class B Patch (3.0%)	
23			Crack/rout/fill, Class D Patch (3.0%)		
25	Class B Patch (5.0%), Diamond grind, Joint reseal	Class A Patch (1.0%), Diamond grind			
26					Crack rout/fill, Class A Patch (1.0%)
28				Mill, SMA OL, Joint reseal	
30	Class B Patch (6.0%), SMA OL		Mill, Class D Patch (1.0%), SMA OL		
33		Class A Patch (1.0%), SMA OL			Mill, Class A Patch (1.0%), SMA OL
34				Crack rout/fill, Class B Patch (5.0%)	
38	Crack rout/fill		Crack/rout/fill, Class D Patch (3.0%)		
39				Mill, SMA OL, Joint reseal	Crack rout/fill, Class A Patch (1.0%)
40		Crack rout/fill			
44	Mill, Class B Patch (5.0%), SMA OL			Crack rout/fill, Class B Patch (6.0%)	
45			Mill, Class D Patch (1.0%), SMA OL		Mill, Class A Patch (1.0%), SMA OL
48		Mill, Class A Patch (0.5%), SMA OL		Mill, SMA OL, Joint reseal	

As with the initial construction costs, MOT, DSE, and CSE services costs were added to all maintenance activities for all sections and pavement types, at 5, 8, and 9 percent of the total direct costs, respectively.

All direct and indirect costs for a specific maintenance activity were converted to present worth using a discount rate of 3 percent (i.e., $1.00 spent in year 38 has a present worth of $0.325 with a 3 percent discount rate).