CHAPTER 606

Life-Cycle Pavement Cost Analysis

Design Memorandum	Revision Date	Sections Affected
20-01	Jan. 2020	Previously 304-20.00
22-02	Jan. 2022	606-1.0, 606-2.02, 606-2.04, 606-2.06, 606-3.01, and 606-3.02
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25-16	Aug. 2025	606-1.0

The applicable design memo revision date is noted in brackets [ ] next to the heading of the affected section.

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CHAPTER 606

LIFE-CYCLE PAVEMENT COST ANALYSIS

Life-Cycle Pavement Cost Analysis is an economic evaluation technique that builds on the principles of economic analysis to evaluate the overall long-term solutions for each type of project. LCPCA considers initial and future agency, user, and other relevant costs over the life of alternatives discounted to provide comparative costs. This technique allows a project's cost to be compared over a specified time period. The selection of design alternatives should be made based on an LCPCA sensitivity analysis for pavement life costs. It is the ultimate goal and primary purpose of the pavement designer to determine a pavement treatment that yields the least cost of ownership to the Department unless otherwise directed by INDOT pavement staff. In the instance that the most cost-effective pavement treatment lacks viability from either a project budget or constructability standpoint, the pavement designer should work with INDOT pavement staff to determine if a different pavement treatment should be recommended or if the programmatic intent should be altered through change management.

This section provides the methodology to perform an LCPCA for a pavement project.

606-1.0 GENERAL REQUIREMENTS [REV. JAN. 2022, MAR. 2025, AUG. 2025]

In the simplest situation, an LCPCA evaluates costs associated with two or more particular strategies or design scenarios over an analysis period including the initial construction and at least one succeeding rehabilitation activity. These costs for the alternate scenarios or money flows are discounted to the present time. A comparison of the net present value of the scenarios is made to provide information regarding one of the factors involved in the selection of a pavement design.

The economic evaluation of two feasible design strategies or design scenarios has no relation to the method of financing, or the total cost of the project. Inflation is not a factor in the evaluation since two or more scenarios' cash flows are being compared over the same time period with presumably the same inflation effects. Constant real dollars should be used in the LCPCA, and then the budget analysis should decide funding sources, inflation rate, and cash-flow requirements.

An LCPCA will be required for the following:

- A new alignment, reconstruction, or rehabilitation (structural) project with mainline pavement of more than 10,000 yd^2.
- All projects where costs of different equitable treatments are close (≤ 10% difference).

The results of the LCPCA should be included in the pavement design memo.

For preventive maintenance projects, a least cost of ownership analysis, (cost analysis = $/lane/mile/year) is also required for each preventive maintenance treatment identified in Section 602-1.04 to compare treatments with differing design lives.

Two scenarios being evaluated with a total net present value within 10% difference (15% for a preservation project with an initial cost as calculated for a cost analysis of less than $750,000) are considered essentially the same.

Other factors should be used to make the final selection such as initial costs, constructability, geotechnical report, work-zone traffic control and user delay costs.

606-2.0 DEFINITIONS

606-2.01 Analysis Period

The analysis period is the number of years over which the pavement life-cycle analysis is conducted. The analysis period should include the initial pavement cost and the cost of at least one subsequent rehabilitation. The analysis period should be at least 50 years in comparing new pavements. In comparing treatments with lesser design lives the number of years may be less.

606-2.02 Discount Rate [Rev. Jan. 2022]

The discount rate is used to equate the cash flows to present worth and determine Equivalent Uniform Annual Cost (EUAC). For general purposes, a 3.5% discount rate can be assumed. However, a range of rates from 0% to 10% can be used to determine if the alternate scenarios are discount-rate sensitive.

606-2.03 Equivalent Uniform Annual Cost

The EUAC is the combining of initial capital costs and all future expenses into equal annual payments over the analysis period.

$$EUAC = (PW)\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

Where: PW = present worth
i = discount rate
n = number of years from year zero.

606-2.04 LCPCA Design Life [Rev. Jan. 2022]

LCPCA design life is the estimated service life of the pavement. The minimum acceptable design life is shown in Section 601-4.0, INDOT Pavement Analyses Philosophy. This should be used for the initial, maintenance, or rehabilitation option. The goal of the pavement designer is to determine a pavement treatment that optimizes pavement design life and is based on least cost of ownership to the department. Overlay designs should be run at a 30-year design life and new, full-depth pavement should be run for a 50-year design life. MEPDG output data should then be analyzed to determine the functional life of the pavement alternative.

The design life of the pavement should be varied to test the LCPCA for sensitivity based on the existing pavement condition, past performance, or the condition of the drainage system. The design life used for the sensitivity analysis should be documented.

The Office of Pavement Engineering will maintain a listing of historical bid summaries associated with pavement construction, rehabilitation, and maintenance contract costs identified as part of the proposed LCPCA. The pavement designer should utilize these costs to compare pavement life-cycle costs of different pavement treatments. Current pavement unit costs are available on the INDOT Pay Items List/Unit Price Summaries webpage at http://www.in.gov/dot/div/contracts/pay.

606-2.05 Pavement Life-Cycle Cost [Rev. Mar. 2025]

A factor in identifying and performing economic analyses of alternatives in the design of new pavement construction or the repair and rehabilitation of existing pavement is the life cycle of the alternative under consideration. The pavement life-cycle cost includes the initial capital cost of construction of pavement items, future maintenance, and future rehabilitation cost estimates.

The pavement life-cycle cost may also include user-delay costs during construction and rehabilitation, user vehicle operating and accident expenses, engineering fees, or other expenditures over the life of the pavement. It may also include the residual value, or salvage value of the pavement, at the end of the analysis time period. The pavement designer may consider the minimum acceptable functional lives for the rehabilitation alternatives over the life of the pavement, however the functional lives of pavement alternatives used in comparing pavement life-cycle costs should be based on MEPDG results and observed past performance of similar pavement treatments.

LCPCA costs should be quantified for the design. INDOT limits costs to the following:

1. initial construction costs;
2. future construction or rehabilitation costs, e.g., overlays, seal coats, or reconstruction;
3. maintenance costs which recur throughout the design period;
4. salvage return or residual value at the end of the design period, which may be a negative cost;
5. traffic-control costs if they are involved.

606-2.06 Present Worth [Rev. Jan. 2022]

INDOT uses deterministic LCPCA and present value for pavement alternative analysis, not EUAC. The present worth (PW) is the value of money at year zero of future expenditures. The future cash flow is discounted by the discount rate to determine PW. The equation for the present worth of a future overlay is as follows:

$$PW = F\left[\frac{1}{(1+i)^n}\right]$$

Where: F = future construction cost
i = discount rate
n = number of years from year zero.

606-2.07 Salvage Value (SV)

Salvage value is the residual value of the pavement's remaining service life at the end of the analysis period. As an example, if the pavement surface has 5 yrs. of remaining life at the end of the analysis, the pavement has a remaining value which has not been used. SV is defined as the construction cost of the last cycle times the ratio of the remaining service years to the last cycle design life. The SV of the pavement is calculated from the equation as follows:

$$SV = (C)\left(\frac{RL}{DL}\right)$$

Where: C = last cycle construction cost, $
RL = remaining service life, yr.
DL = last cycle design life, yr.

606-3.0 ANALYSIS STEPS

An example of LCPCA strategy follows. Differing pavement work types with different design lives may be used in alternate LCPCA strategies. LCPCA examples are available on the Pavement Design webpage at https://www.in.gov/indot/3418.htm.

606-3.01 HMA Pavement [Rev. Jan. 2022, Mar. 2025]

LCPCA for an HMA pavement uses a 50-year analysis period. Strategies differ depending on the use of traditional joint adhesive or void-reducing asphalt membrane (VRAM). See tables below.

HMA Pavement Life Cycle using Joint Adhesive		
Year	Treatment Category	Description
0	None	Initial Pavement Construction
3	PM	Joint/Crack Seal. Qty based on 25% Longitudinal Joint Length
6	PM	Joint/Crack Seal. Qty based on 50% Longitudinal Joint Length
9	PM	Joint/Crack Seal. Qty based on 75% Longitudinal Joint Length
12	PM	Joint/Crack Seal. Qty based on 100% Longitudinal Joint Length
16	PM	Mill 1.5 in. and Overlay 1.5 in. Surface, with 1% partial-depth HMA patching based on mainline pavement area
19	PM	Joint/Crack Seal. Qty based on 25% Longitudinal Joint Length
22	PM	Joint/Crack Seal. Qty based on 50% Longitudinal Joint Length
25	PM	Joint/Crack Seal. Qty based on 75% Longitudinal Joint Length
28	PM	Joint/Crack Seal. Qty based on 100% Longitudinal Joint Length
30	PM	Mill 1.5 in. and Overlay 1.5 in. Surface, with 2% partial-depth HMA patching based on mainline pavement area
33	PM	Joint/Crack Seal. Qty based on 25% Longitudinal Joint Length
36	PM	Joint/Crack Seal. Qty based on 50% Longitudinal Joint Length
39	PM	Joint/Crack Seal. Qty based on 75% Longitudinal Joint Length
42	R	Mill 4 in. and two-layer Overlay. 4 in. = 1.5 in. Surface on 2.5 in. Intermediate. Shoulder: mill 1.5 in and Overlay 1.5 in. Surface. 4% full-depth patching based on mainline pavement area
45	PM	Joint/Crack Seal. Qty based on 25% Longitudinal Joint Length
48	PM	Joint/Crack Seal. Qty based on 50% Longitudinal Joint Length
50	None	End of LCPCA Salvage Value at Year 50 = $X.XX (6 years Remaining Service Life of Major Rehabilitation Treatment)
PM = Preventive Maintenance, R = Major Rehabilitation		

HMA Pavement Life Cycle using Void-Reducing Asphalt Membrane (VRAM)		
Year	Treatment Category	Description
0	None	Initial Pavement Construction
3	PM	Thermal/Random Crack Seal - 100 lft/lane/mile
6	PM	Thermal/Random Crack Seal - 200 lft/lane/mile
9	PM	Random Crack Seal - 200 lft/lane/mile
12	PM	Random Crack Seal - 200 lft/lane/mile
16	PM	Mill 1.5 in. and Overlay 1.5 in. Surface. 1% partial-depth HMA patching based on mainline pavement area
19	PM	Thermal/Random Crack Seal - 100 lft/lane/mile
22	PM	Thermal/Random Crack Seal - 200 lft/lane/mile
25	PM	Random Crack Seal - 200 lft/lane/mile
28	PM	Random Crack Seal - 200 lft/lane/mile
30	PM	Mill 1.5 in. and Overlay 1.5 in. Surface, with 2% partial-depth HMA patching based on mainline pavement area
33	PM	Thermal/Random Crack Seal - 100 lft/lane/mile
36	PM	Thermal/Random Crack Seal - 200 lft/lane/mile
39	PM	Random Crack Seal - 200 lft/lane/mile
42	R	Mill 4 in. and two-layer Overlay. 4 in. = 1.5 in. Surface on 2.5 in. Intermediate. Shoulder: mill 1.5 in. and Overlay 1.5 in. Surface. 4% full-depth patching based on mainline pavement area
45	PM	Thermal/Random Crack Seal - 100 lft/lane/mile
48	PM	Thermal/Random Crack Seal - 200 lft/lane/mile
50	None	End of LCPCA Salvage Value at Year 50 = $X.XX (6 years Remaining Service Life of Major Rehabilitation Treatment)
PM = Preventive Maintenance, R = Major Rehabilitation		

606-3.02 PCCP [Rev. Jan. 2022, Mar. 2025]

LCPCA for PCC pavement uses a 50-year analysis period as follows.

PCC Pavement Life Cycle		
Year	Treatment Category	Description
0	None	Initial Pavement Construction
15	CPR	Partial Depth Longitudinal and Transverse Joint Repair - 3% Joints Full Depth PCCP Patch – 1.5% of mainline pavement area
28	CPR	Partial Depth Longitudinal and Transverse Joint Repair - 5% Joints Full Depth PCCP Patch – 3% of mainline pavement area Profiling (Diamond Grinding) and Grooving 50% mainline pavement area
40	R	Partial Depth Longitudinal and Transverse Joint Repair - 10% Joints Full Depth PCCP Patch - 5% of mainline pavement area Profiling (Diamond Grinding) and Grooving - 100% mainline pavement areas
50	None	End of LCPCA Salvage Values at Year 50 = $0.00
CPR = Concrete Pavement Restoration, R = Major Rehabilitation		