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700 Life-Cycle Cost Analysis

701 Introduction

Life-Cycle Cost Analysis (LCCA) is a process for evaluating the economic worth of a pavement segment by analyzing initial costs and discounted future costs such as surface treatment, resurfacing, rehabilitation, and reconstruction costs over a defined analysis period. This section outlines some of the requirements for preparing an LCCA. Other details about the LCCA are given in Section 100.

701.1 Discount Rate

ODOT uses the discount rate provided by the Office of Management and Budget (OMB) in Circular A-94. Specifically, the 30-year real interest rate is used. The current discount rate can be found on the OMB website at http://www.whitehouse.gov/omb/.

702 Initial Construction

All alternatives for initial construction are designed using the procedures outlined in this Manual. Initial construction is considered to take place in year zero.

All differential pavement items are to be included in the analysis such as excavation, stabilization, pavement removed, base, and pavement. Non-pavement items and items common to all alternatives can be neglected. Items such as striping, signing, lighting, guardrail, barrier, underdrains, culverts, bridges, embankment, etc., are not pavement items, are essentially equal for all alternatives and are not to be included in the analysis. On new locations, earthwork items including stabilization are common to all pavement alternatives and are essentially equal and are not to be included.

For rehabilitations that raise the elevation of the existing pavement, a cost needs to be included for maintaining clearance under overhead structures and for meeting elevations of at-grade bridges. This cost can be calculated in various ways, most common is to calculate the cost to remove the existing pavement, excavate down, and build back up with new pavement. Another way is to calculate the cost of jacking the bridges, including any approach work necessary on overheads. A third option could be a combination of the two.

It is not important which method is selected for computing cost of maintaining clearance. What is important is that the costs are included in the analysis. The same method of calculating the costs is to be used for all alternatives. The method used in the LCCA for computing cost of maintaining clearance does not have to be the actual method used in the plans and in construction.

703 Future Rehabilitation

703.1 Introduction

The future rehabilitation required to keep the pavement in serviceable condition for the next 35 years must be predicted. Routine and reactive maintenance performed by ODOT forces are not included in the analysis due in part to lack of dependable data. Only contract rehabilitation projects are considered.

ODOT does not use salvage value. The rehabilitation schedules listed below result in approximately equal condition at the end of the analysis period. The salvage values are considered equal and are not included in the analysis.

703.2 Rehabilitation Schedules

The rehabilitation schedules given below were developed from an analysis of ODOT pavement performance data. The analysis will be updated periodically and the rehabilitation schedules updated accordingly. The schedules below are to be used without deviation.

The schedules list only major items of work. The LCCA should include the specification items needed to complete the work described such as tack coats and pavement sawing.

703.2.1 Flexible Pavement

Flexible pavement includes new pavement on a new alignment and complete replacement of existing pavement.

Year 14: 1.5" overlay with planing (driving lanes only).

Year 24: 3.25" overlay with planing (driving lanes and shoulders) with 1% patching planed surface.

Year 34: 1.5" overlay with planing (driving lanes only).

703.2.2 Rigid Pavement

Rigid pavement includes new pavement on a new alignment and complete replacement of existing pavement.

Year 22: Diamond grinding (driving lanes plus one foot of each shoulder) and full dept rigid repairs of 4% of the driving lanes surface area.

Year 32: 3.25" asphalt overlay and full depth rigid repair of 2% of the driving lanes surface area.

703.2.3 Composite Pavement

Composite pavement includes new pavement on a new alignment and complete replacement of existing pavement. The performance of newly constructed composite pavements has not been studied as relatively few have been constructed. Since composite pavement is a hybrid of rigid and flexible pavements, a hybrid rehabilitation schedule may be derived from the rigid and flexible schedules.

The timing, width, and thickness of each rehabilitation shall be the same as the flexible pavement schedule given in Section 703.2.1. A quantity of full depth rigid repairs equal to 2% of the driving lanes surface area shall be included with the overlay at years 14 and 34, and 3% at year 24.

703.2.4 Unbonded Concrete Overlay

An unbonded concrete overlay is a new concrete pavement built on top of an old concrete pavement with a bondbreaker layer in between. The future rehabilitation schedule is the same as rigid pavement given in Section 703.2.2.

703.2.5 Fractured Slab Techniques

Fractured slab techniques include crack & seat, and rubblize & roll. The future rehabilitation schedule for all fractured slab techniques is the same as flexible pavement given in Section 703.2.1.

703.2.6 Whitetopping

Whitetopping is a new concrete pavement built on an old flexible pavement. The future rehabilitation schedule is the same as rigid pavement given in Section 703.2.2.

704 Total Cost

Once all the costs for initial construction and future rehabilitation have been calculated, they are summed to determine the net present value of each alternative. Future rehabilitation costs are discounted to account for and the time value of money.

704.1 Discounting

Discounting is a simple yet effective way to account for the time value of money. The discount rate can be thought of as the difference between market interest rates and the general rate of inflation. For example, if one-year Certificates of Deposit (CD) are paying 5.5% while inflation is running 2.0% per year, the discount rate would be 3.5%. Similarly, if CDs are paying 8.0% and inflation is running 4.5%, the discount rate is still 3.5%. Using a discount rate eliminates the need to predict what inflation will do for the next 35 years or what return one might get on an investment.

The formula for applying the discount rate is as follows:

$$(P/F,i\%,n) = \frac{1}{(1+i)^n}$$

where:

(P/F,i%,n) = discount factor

i = discount rate from OMB Circular A-94

n = year costs occur

An example of how to use the discount rate and calculate total cost is shown in Figure 703-1.

705 Results Presentation

The Office of Pavement Engineering prepares all LCCAs and pavement selection packages. A standard format for presenting the information is still evolving. Once a standard is established, a general description will be added to this Manual.

List of Figures

# Discounting Example	**704-1** July 2014
	Reference Section **704.1**

Given:

- Initial Construction (Year 0): $16,000,000
- First Rehabilitation (Year 14): $1,400,000
- Second Rehabilitation (Year 24): $2,300,000
- Third Rehabilitation (Year 34): $1,400,000

Problem:

Solve for the net present value using a discount rate of 1.9%.

Solution:

Calculate the discount factor for each year using the equation given in Section 704.1.

$$(P/F,1.9\%,0) = \frac{1}{(1+0.019)^{0}} = 1.0$$

$$(P/F,1.9\%,14) = \frac{1}{(1+0.019)^{14}} = 0.7684$$

$$(P/F,1.9\%,24) = \frac{1}{(1+0.019)^{24}} = 0.6365$$

$$(P/F,1.9\%,34) = \frac{1}{(1+0.019)^{34}} = 0.5273$$

Multiply costs by discount factors and sum to find Net Present Value (NPV).

NPV = (16000000)*(1)+(1400000)*(0.7684)+(2300000)*(0.6365)+(1400000)*(0.5273)
= $19,300,000