Understanding Equivalent Pavement Designs

Determining the True Life-Cycle Cost of Pavements

Life-cycle costs are an increasingly important decision point in the selection of pavement materials. Life-cycle cost analysis (LCCA) requires careful consideration of the complete costs over time.

Figure 1 illustrates some of the key considerations that are critical to an objective life-cycle cost analysis.

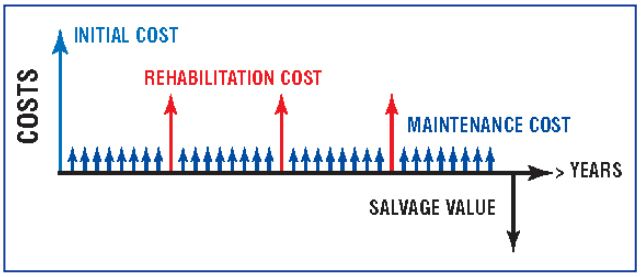


Figure 1. Illustration shows factors considered in life-cycle cost analysis of pavements.

The basic approach to LCCA is basic enough, as it simply involves evaluation of the cost to construct the pavement system, as well as to keep it in good condition over time.

One of the challenges of an objective LCCA is to avoid "apples to oranges" comparisons of the pavement designs.

LCCA becomes more challenging because of a number of differences between concrete pavements and asphalt pavements. For example, concrete pavements are generally constructed in one pass, while asphalt pavements typically have a structural component and a top layer (wearing course).

Another key difference is temperature sensitivity. Concrete pavements are not sensitive to temperatures fluctuations, so thicknesses do not have to be increased in areas with higher mean average ambient temperatures (MAAT), as illustrated in Figure 3.

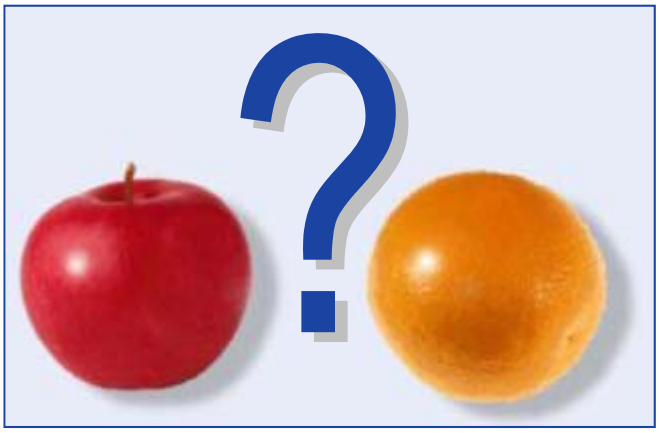


Figure 2. Equivalent pavement designs are the key to avoiding "apples to oranges" comparisons of pavement type.

Equivalent Pavement Designs

Accurate LCCA begins with an evaluation of equivalent pavement designs.

Two industry-recognized methods used to determine pavement type selection include ACPA's StreetPave design software and the Asphalt Institute's design procedure. (StreetPave incorporates a life-cycle cost module that enables design engineers to evaluate the total costs of a pavement for 30 years or longer.)

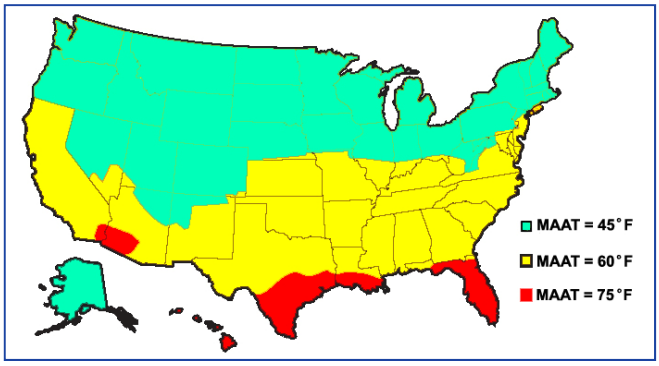


Figure 2. Higher mean average temperatures will require thicker sections of asphalt pavements.

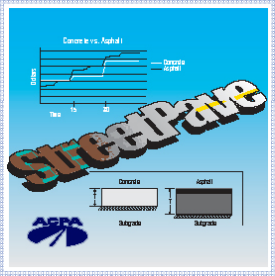
Using these resources, a design engineer can input different variables to obtain equivalent pavement designs, i.e., those with similar load-carrying capacity for a given time period.

Figure 4 provides examples of different road classifications and the initial, rehabilitation, and maintenance costs for the equivalent concrete and asphalt sections. In these examples, concrete strength was 4000 psi and the design did not include integral curbs. If either the concrete strength were increased or an integral curb and gutter were used as design options, the initial concrete cost would be reduced.

The LCCA examples are based on:

- *Engineering News Record*'s quarterly "Construction Economics " report.
- Initial costs based on 1-mile of 12' wide pavement with curbs placed separately.
- A 30-year design life.

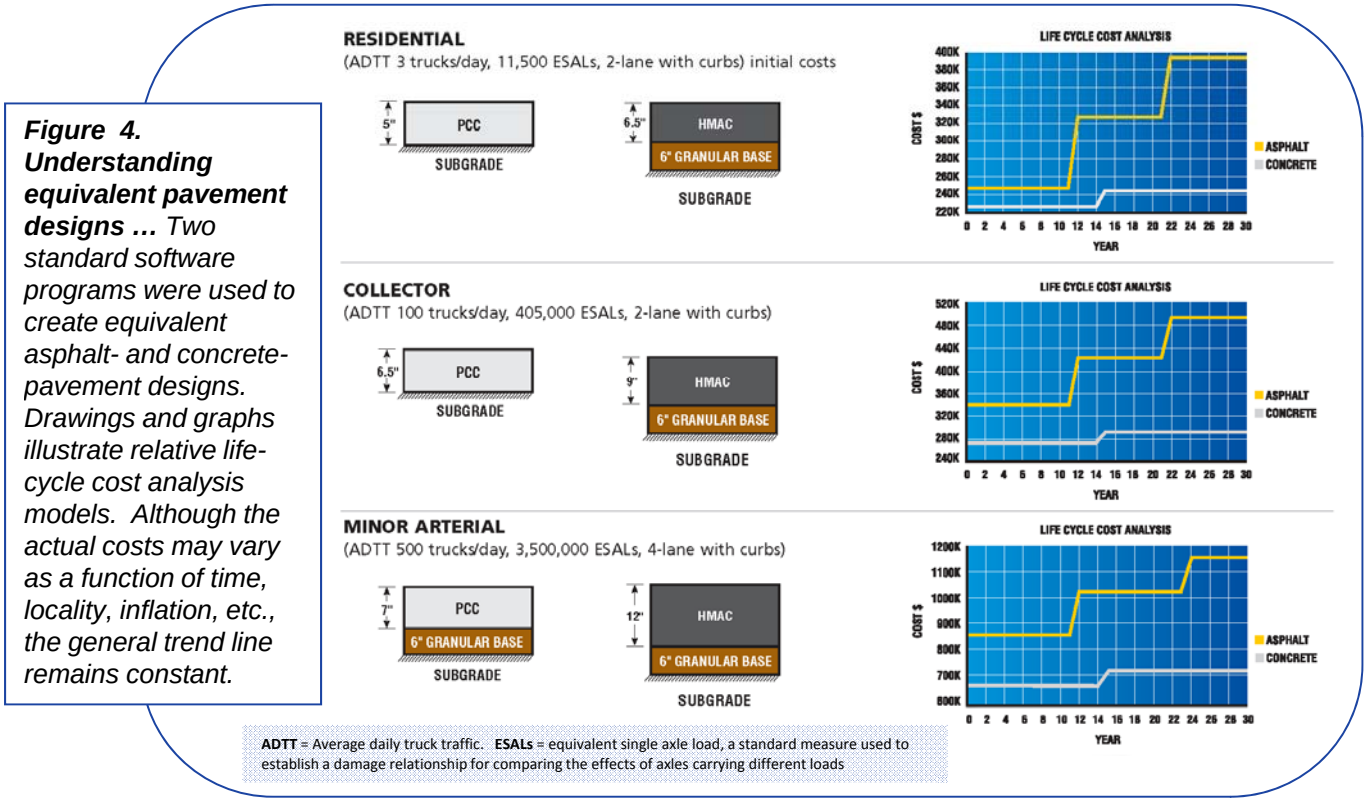
Other Variables



Concrete Pavement
- Flexural Strength 600 psi.
- Reliability 80%.
- *k*-value = 100.
- Design Life 30 years.

Asphalt Pavement
- MAAT 45ºF.
- Modulus of Resilience (subgrade support) 3000 psi.
- Design Life 30 years.

It should be noted that if integral curbs were included with the initial concrete pavement, an additional $45,000 cost savings would be realized.



ADTT = Average daily truck traffic. **ESALs** = equivalent single axle load, a standard measure used to establish a damage relationship for comparing the effects of axles carrying different loads

Figure 4. Understanding equivalent pavement designs ... *Two standard software programs were used to create equivalent asphalt- and concrete-pavement designs. Drawings and graphs illustrate relative life-cycle cost analysis models. Although the actual costs may vary as a function of time, locality, inflation, etc., the general trend line remains constant.*

Source Material

- Asphalt Thickness Design software, Asphalt Institute, Lexington, Ky.
- Engineering News Record, a publication of The McGraw-Hill Companies, Inc., New York, N.Y. Review of August 2006 and April 2010 issues.
- StreetPave™ software, the American Concrete Pavement Association, Skokie, Ill.
- "Construction and Materials Tips," 3rd quarter 2005, Texas Department of Transportation, Austin, Texas.