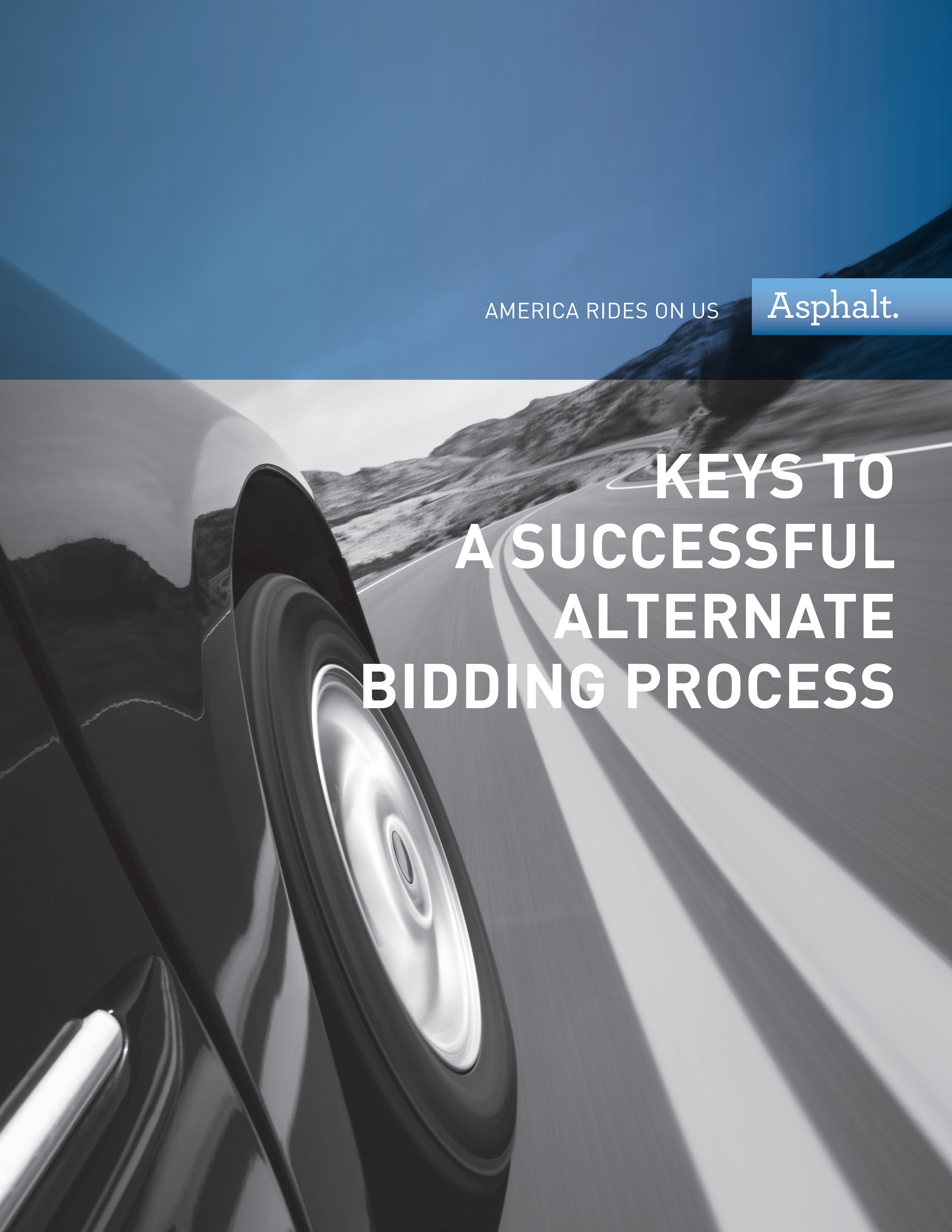

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Asphalt.

KEYS TO A SUCCESSFUL ALTERNATE BIDDING PROCESS

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INTRODUCTION

With alternate bidding, road and highway agencies offer the opportunity to submit a bid to construct a pavement as either an asphalt pavement or a Portland cement concrete pavement. Alternate bids can take several forms:

- A + B (initial cost + construction time),
- A + B + C (initial cost + construction time + future costs), or
- A + C (initial cost + future costs).

In the A + B alternate bid, the **time to construct** the project is considered to have a monetary value. It is typically applied when there is a distinct advantage to completing the initial construction as quickly as possible. In the A + B + C and the A + C bids, "future costs" are the costs to rehabilitate the respective pavements. Future costs may include user delay costs – i.e., the cost to motorists and other road users when the pavement is taken out of service for rehabilitation.

FIGURE 1: LIFE-CYCLE COST APPROACH

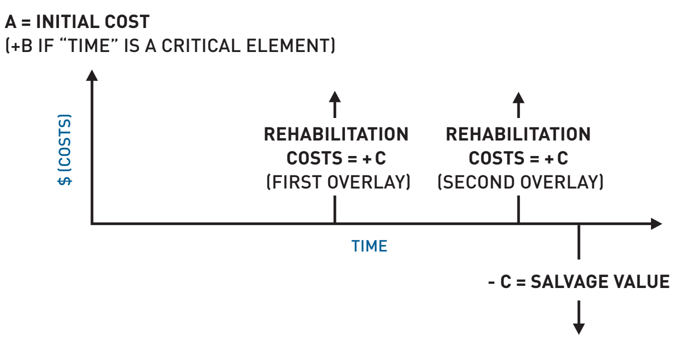

FIGURE 2: EXAMPLE OF INITIAL AND FUTURE COSTS

ALTERNATE BID EXAMPLE (A + C)	INITIAL COST, A	FUTURE MAINTENANCE & REHABILITATION COSTS, C
Pavement Type I	$ 8,000,000	$ 1,000,000
Pavement Type II	$ 7,800,000	$1,300,000

Consider the example in Figure 2, where Pavement Type I has a higher initial cost and lower future cost than Pavement Type II. The "C factor" is the difference in future costs between Pavement Type I and Pavement Type II, including maintenance and rehabilitation costs, amounting to $1,300,000 - $1,000,000 = $300,000. These future costs are presented as the future value of current dollars. The use of a discount rate to account for the time value of money will be discussed later. As shown below, the difference in maintenance and rehabilitation costs between the two pavements is added to Pavement Type II.

Thus, the project will be awarded to Pavement Type I, based on total costs.

PAVEMENT TYPE I BID	$ 8,000,000	
PAVEMENT TYPE II BID	$ 8,100,000	($ 7,800,000 + $ 300,000)

Traditionally, bids are awarded to the lowest bidder on the *initial* cost. Since 1990, the Federal Highway Administration's Special Experimental Project No. 14 – Innovative Contracting (SEP-14) has allowed Departments of Transportation (DOTs) to make awards on competitive non-traditional projects. "SEP-14" approval is not required if a life-cycle future cost "C" adjustment factor is not used, but it is necessary when a life-cycle future cost "C" adjustment factor is included in determining the successful bidder.

Initially, the FHWA did not encourage the use of alternate bids to determine mainline pavement bids, primarily due to the difficulties in developing truly equivalent pavement designs. However, they have shifted to a neutral position. Disagreements between agency officials and industry over initial performance periods, rehabilitation strategies, and rehabilitation performance periods, assumed in the LCC to calculate the "C factor", have been and continue to be a stumbling block for alternate bidding.

The new AASHTO Mechanistic-Empirical Pavement Design Guide (MEPDG) provides the tools to develop equivalent pavement designs. Lane rental and/or user delay costs will vary from project to project based on the average daily traffic (ADT), percentage breakdown of automobiles and trucks, the number of lanes, etc. and are beyond the scope of this document. The purpose of this document is to highlight key points to consider when future maintenance and rehabilitation costs, the "C factor," are included in awarding a paving project.

KEY FACTORS in Calculating Life-Cycle Costs

» PERFORMANCE PERIOD

This is the time frame between opening a project to traffic and the next rehabilitation. Specifically, for an asphalt pavement it is the time between the initial opening to traffic and the first overlay, and subsequently the time intervals between future overlays. Performance periods, particularly the initial performance period, have a significant impact when calculating the present worth life-cycle analysis, favored by FHWA. It is not uncommon for the initial construction plus the first rehabilitation to account for 80 to 90 percent of the agency's total present worth costs in a 40-year analysis. Overlay performance periods may be shorter than initial performance because of existing conditions. Two examples might be an underlying distress that remains uncorrected or an overlay thickness based on economic limitations rather than structural need. Since the majority of asphalt construction projects are overlays (typically 1 to 2 inches) it often leads to a skewed perception of asphalt performance. **It is important that performance periods be separated into initial construction and rehabilitation performance periods.** A February 2005 report by Von Quintus et al. for the Federal Highway Administration found that ".... The expected service life for any of the distresses to occur at a moderate level is 22 years or more, based on a 50 percent probability." (Ref. 1) "A moderate level of distress was used to determine the time or age of the flexible pavements to an unacceptable surface condition." (Fig. 3).

FIGURE 3 — EXPECTED SERVICE LIFE BASED ON DIFFERENT LEVELS AND MAGNITUDES OF DISTRESS [REF. 1]

Distress Type	Expected Service Life Based on a 50% Probability of Occurrence, Years	
	Low Distress Level	Moderate Distress Level
Fatigue Cracking	22	25
Longitudinal Cracking in Wheel Path	22	28
Transverse Cracking	19	22
Longitudinal Cracking Outside Wheel Path	18	22
Rutting	17	22
Roughness or IRI	20	22

It is important for each agency to establish performance periods based on their records. As an example, the Maryland State Highway Administration's Pavement Type Selection program evaluated thousands of miles of its roadways (new construction, first overlay, second overlay, and third overlay). They found the performance periods for the initial construction and the first overlay to be 14.8 and 11.9 years respectively (Fig 4).

FIGURE 4: MARYLAND DOT'S REHABILITATION SCHEDULE FOR ASPHALT PAVEMENTS

Average Service Life		Lane-Mile Population Used in Service Life
Cycle		Flexible
Initial	14.8	4,527
1st Rehabilitation	11.9	3,000
2nd Rehabilitation	11.1	1,227
3rd Rehabilitation	12.0	355

» REHABILITATION PLAN

It is important to have a specified plan to rehabilitate the pavement at the end of each performance period for both alternatives. Does the agency patch? If yes, what percent of the pavement is patched? Does the rehabilitation include an overlay, or mill and overlay? **The rehabilitation plan**, at the end of each performance period, **should be clearly defined and it should be based on the agency's historical experience**. The data in their pavement management system can be the key to finding these answers.

» MATERIAL COSTS

Present worth calculations are based on constant dollars and the real discount rate. As such, **prices incorporated into the analysis should be representative of projects of similar scope, quantities and geographic area**. One method of calculating material unit costs is to use bid tabs from the previous three years, eliminating the outliers, and then statistically determining the mean and standard deviation.

» ANALYSIS PERIOD

Per FHWA's *Life Cycle Cost Analysis in Pavement Design* guideline (Ref 2), the analysis should incorporate at least one rehabilitation activity for each pavement type. The analysis should incorporate at least one rehabilitation activity. Analysis periods typically range between 35 and 50 years. **All pavement strategies should be evaluated for the same number of years**.

» DISCOUNT RATE

Future costs should be estimated in current dollars and then discounted back to the present using the real discount rate. Real discount rates reflect the true time value of money, accounting for both inflation and bond rates. All initial construction and rehabilitation costs should be present-day cost. Inflation is accounted for when using the real discount rate. (Ref. 2) A reasonable discount rate is one that reflects historical trends over a long period of time. **It is suggested that Circular A-94 from the White House's Office of Management and Budget, (Ref. 3) along with the annual Appendix, be used to select the appropriate discount rate**. Circular A-94 suggests using the 30-year "real discount rate" for an analysis period greater than or equal to 30 years. The real discount rate normally falls in the range of 3 to 5 percent.

» SALVAGE VALUE

Salvage value represents the value of the investment at the end of the analysis period. This is often referred to as the remaining service life (RSL). As an example, an overlay expected to last 15 years is placed in year 35 of a 40-year analysis. The remaining service life of the overlay at the end of the analysis period is 10 years. The salvage value will be calculated at 66 percent of the cost of the overlay at year 35. Salvage values tend to have minimal impact because they are discounted over the entire analysis period. A 3 percent discount rate at year 40 has a coefficient of 0.3066, meaning $1 today will only be worth 31 cents 40 years from now.

Perhaps more significant than the salvage value is the fact that an asphalt pavement is 100 percent recyclable (asphalt as asphalt and aggregate as aggregate). Conversely, the cement portion of a portland cement concrete pavement cannot be reused as cement. It can only be crushed and used as aggregate.

» SPEED OF CONSTRUCTION AND USER DELAY

User costs are the differential costs incurred by the motoring public associated with the maintenance and rehabilitation of the pavement.

User costs typically include

- Vehicle operating cost (VOC)
- User delay cost
- Crash cost.

The FHWA's *Life-Cycle Cost Analysis in Pavement Design* (Ref. 2) and Real Cost software provide guidance in this area. User costs are calculated on a daily basis and require the user to input the number of days it will take to complete the rehabilitation. This document chooses to leave the VOC, crash and user delay cost guidance to the FHWA's manual and software. The focus here will be on the importance of estimating the number of days it will take to complete the rehabilitation, sometimes known as the *construction duration*. **Construction duration, based on the agency's historical data, should reflect quantities placed on a typical work day.** Examples might include tons of hot-mix or warm-mix asphalt placed in one day and cubic yards of concrete pavement placed in one day. Figure 5 is representative of a Construction Duration Table. A construction duration table should be used when calculating user delay costs. That table should be based on discussions between both industries and the agency. Life-cycle cost based solely on agency costs (excluding user delay costs) do not require a construction duration table. **Allowing the motoring public to use the pavement during peak driving hours and performing construction activities only during off-peak**

FIGURE 5 — CONSTRUCTION DURATION ESTIMATES

Construction Operation	Average Duration	Conservative Duration
HMA Placement	1,400 – 1,500 tons/day	800 – 1,000 tons/day
HMA Grinding	8,000 – 10,000 SY/day	
HMA Base and Base Widening/Patching	Increase Conservative Duration if you have large/wide pulls	200 SY/day or 100 tons/day
PCC Placement	3,200 SY/day	
PCC Patching	250 – 300 SY/day	
PCC Grinding	5,600 – 7,000 SY/day	
Clean and Seal Joints	5,000 – 6,000 LF/day	
Graded Aggregate Base Placement	7,000 SY/day	3,000 – 4,000 SY/day
Class 1-A Excavation	2,000 SY/day	
Remove and Replace Concrete Curb and Gutter	300 LF/day for forming or slipforming	

Note: *Additional time required for PCC pavements to cure should also be included.*

hours can significantly reduce user delay costs and should always be considered. The default values in FHWA's *Life Cycle Cost Analysis in Pavement Design* (Ref.2, Table 3.1) show that the number of vehicles passing through the work zone can be reduced by as much as 80 to 85 percent when limiting work zones to between the hours of 8:00 pm and 6:00 am. **The ability to use off-peak hours for construction, with no daytime closures for pavement to cure, is a distinct benefit of asphalt pavements.**

CONCLUSIONS

In conclusion, there will never be sufficient funding to meet all the needs of the nation's roadways. Therefore, it is important to optimize every highway dollar. One way agencies have chosen to optimize funding is through alternate bidding. The agencies expect the competitive bidding between and within the asphalt and concrete industries to result in the most economical pavement. The asphalt pavement industry supports alternate bidding provided the guidelines are based on technical merits.

When an agency chooses to include user delay costs, the advantages of off-peak (evenings and weekends) paving should be considered. It is also important to establish construction durations that are representative of each industry's capability.

For accuracy, it is also vital that every aspect of the alternate bidding process be transparent to include publishing the "C" factors.

Alternate Bid Checklist

WHEN AGENCY COSTS ONLY ARE CONSIDERED

- ❒ Pavement designs should be equivalent
- ❒ Separate performance periods for new construction and rehabilitation activities should be used
- ❒ Rehabilitation strategies should reflect past activities
- ❒ Material costs should represent agency's present-day costs on projects of similar scope and quantities, over a period of time
- ❒ Analysis periods for pavement types should be equal, and within a range of 35 to 50 years
- ❒ Real discount rate should be selected from the White House's Office of Management and Budget *Circular A-94*

WHEN USER DELAY COSTS ARE CONSIDERED

- ❒ Construction duration should represent quantity of work completed in a typical work day. In the case of concrete pavements, additional days should be added to reflect the curing period.
- ❒ Off-peak hours should be considered in user delay calculations

REFERENCES

1) *Expected Service Life and Performance Characteristics of HMA Pavements in LTPP*, Applied Research Associates, Von Quintus, H.L., et al., February 2005. http://pubsindex.trb.org/view.aspx?id=836227

2) *Life Cycle Cost Analysis in Pavement Design*, Report No. FHWA-SA-98-079, Federal Highway Administration, Washington, DC, 1998. http://isddc.dot.gov/OLPFiles/FHWA/013017.pdf

3) *Circular No. A-94*, White House Office of Management and Budget. http://www.whitehouse.gov/omb/rewrite/circulars/a094/a094.html

ADDITIONAL RESOURCES

1) The Asphalt Pavement Alliance offers two user-friendly and unbiased software programs for life-cycle cost analysis (LCCA). They follow the FHWA guidelines to help officials compare the economics of alternative designs for a given road project. LCCA Original is a powerful program which can be used for complex projects. LCCA Express is a simplified version of LCCA Original. Geared to less-complex projects, it's quick and easy to use. The software programs are available as free downloads at **www.AsphaltRoads.org**.

2) ***Pavement Type Selection: A Position Paper***, published by the Asphalt Pavement Alliance, is available free at **www.AsphaltRoads.org**. This 20-page document sets out principles that state DOTs and other agencies can use in choosing whether to use asphalt or concrete pavement for a particular roadway. It discusses the *Design Guides* published by the American Association of State Highway and Transportation Officials and provides a bibliography of important publications on the subject. The publication also includes a chart summarizing the life-cycle cost inputs from various states and a handy checklist for agencies to use.

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