

**“Asset Management of Streets & Local Roads”**

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ABSTRACT

Asset management is a process that will impact local decision-makers and agencies. Should a municipality invest in longer-term fixes that will decrease annual maintenance dollars? This session explains asset management principles, life-cycle methodologies, pavement management techniques, and how concrete pavements can offer a “mix of

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## **“Asset Management of Streets a**

### **Introduction**

Public works agencies everyday are in search of better transportation network investment decisions and strategies to construct and maintain roadway systems. The ultimate asset management question is how to make limited budget dollars stretch and provide a street system that offers a high level of service to the public.

### **Asset Management – What is it?**

Asset management can be described as a systematic process of maintaining, upgrading, and operating physical assets, such as roadways and bridges, in a cost-effective way. It combines engineering, business management, economics, and the latest computer-aided technology. A major goal of asset management is to use the process in both the short- and long-term decision-making in the planning, budgeting, and operating functions so the physical assets stay at the highest condition level. For pavements, the idea is to preserve the pavement network to insure safety and serviceability, while optimizing all available resources.

Items needed to complete an asset management system include inventory, condition assessment, asset evaluation, performance prediction measures and trend indicators, cost estimates of options and resulting impacts, and engineering/economic optimization tools.

The historic approach has been to manage on an “asset-by-asset” basis. Both the preservation strategies and the maintenance approaches were reactive. The “fix the worst first pavements” mentality prevailed. There was limited investment on good and fair pavements. Investment history was used on a limited basis.

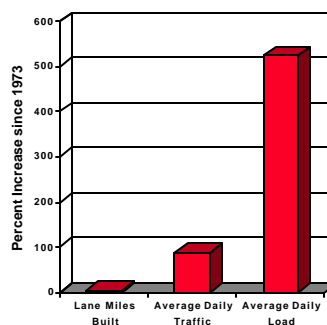
A new approach is to develop long-term network goals, emphasize preservation, proactively manage deterioration, develop a comprehensive maintenance plan, and a commitment to allocate the necessary resources over time.

### **Why is a new approach needed for roadways?**

The nation’s roadways are more heavily traveled with heavier loads with the need to serve this traffic increase. In fact since 1973, average daily traffic has increased by 86 percent, average daily load has increased by 550 percent while the roadway mileage has increased only 3 percent.

## Why is it needed with Roads?

- Roads mileage increased by 3%
- Average Daily Traffic has increased by 86%
- Average Daily Load has increased by 550%



**Figure 1:** Traffic Increase on Roadways

Another reason is that local agencies need to show the taxpayer and motoring public that the agency is properly doing their job and wisely investing tax dollars in the transportation infrastructure. Asset management is good for the public agency business practice and good for the local business community in keeping taxes at the appropriate level to support the infrastructure that the community depends upon for economic vitality.

Still, the newest reason for asset management is the Government Accounting Standards Board (GASB) Statement No. 34 issued June 10, 1999. According to GASB Chairman, Tom L. Allen, Statement No. 34 is “the most significant change in the history of governmental accounting. It represents a dramatic shift in the way state and local governments present financial information to the public.” This new standard will influence the community policies and procedures.

### **Impact of GASB Statement No. 34 to Local Governments (Reference Pricewaterhouse Coopers)**

The impacts to an agency policies and procedures include:

- Report information about public infrastructure assets.
- Report on the overall state of the agency’s financial health, not just individual
- Provide comprehensive information reflecting the cost of delivering services to citizens.
- Provide alternative methods for reporting the condition of infrastructure assets.

GASB rationale for infrastructure reporting include:

- Determine whether current-year revenues were sufficient to cover the cost of current-year services.

- Assess the service efforts and costs of programs.
- Determine whether the governments financial position improved or deteriorated as a result of the year's operations.
- Assess the government's financial position and condition.
- Assess the service potential of physical resources having useful lives that extend beyond the period.

The key asset management system components to support GASB No. 34 are:

- Asset inventory database
- Asset valuation processes
- Performance measures and standards
- Condition assessment processes
- Asset management planning/programming systems
  - Pavement management systems
  - Maintenance management systems
- Asset renewal/replacement analysis methods
  - Life-cycle costing
  - Cost-effectiveness analysis
  - Equivalent annual cost
  - Longevity cost index
- Asset disposal policies and procedures

### **Goals of Street and Road Infrastructure Asset Management**

The foregoing information raises the question on how to properly plan infrastructure improvements and maintenance and implement a systemized approach. The way to do this is to look for network solutions and not just individual project solutions. This procedure facilitates longer term planning that serves both the local taxpayer and requirements of GASB No. 34.

### **Developing a Network Comparative Analysis Procedure for Asset Management**

Because the goal is to preserve the pavement network while optimizing all available resources, the strategy development must consider the impacts of past actions, and the benefits of scheduled maintenance, restoration, rehabilitation and reconstruction. It should also include a network modeling tool; information for deterioration rates, and cost data. The strategy must also set what the goals for the system will be. An example of such goals are:

- Pavements in critical condition - Address 100%
- Freeway Pavements: 95% in good or fair condition by some established future date, i.e. 10 years
- Non-Freeway Pavements: in good or fair condition by some established future date, i.e. 10 years

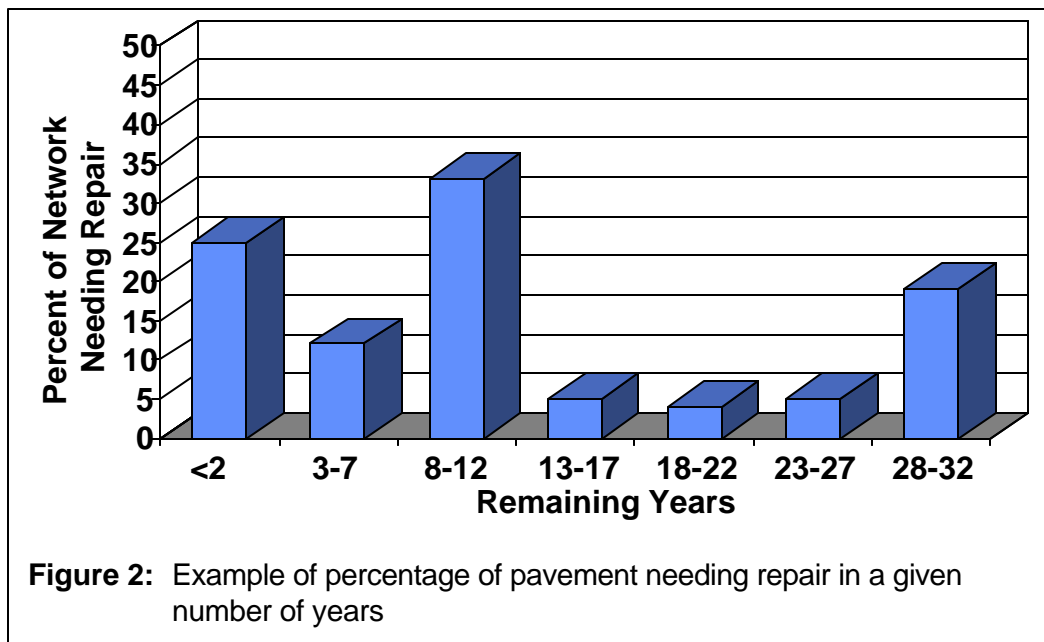
Once goals are set, the agency needs to determine or work through four key issues:

1. Average years of remaining service
2. Preservation procedures (Mix of Fixes), which are activities used to extend pavement life.
3. Network impacts of these activities
4. LCCA and total pavement costs

The basic premise is to look at the existing network and determine its condition. With this, the agency determines what performance they need out of their repairs, and then choose those repairs that give that performance. Finally, the agency compares alternates to see which are the most cost effective.

**Average Years of Remaining Service**

The average years of service is the life each section of roadway has before its next major rehabilitation. An easy way to express this is as percentage of pavement needing repair in a given number of years (Figure 2). Essentially, the longer the life of the system, the greater the average years of service for the whole network and the more benefit it provides. This is because the longer the life of the system the less that needs to be repaired at any given time. This lowers the yearly cost to the agency by spreading them over longer time periods.



Considering a hypothetical 300-mile roadway network with mostly short-life pavements can see the effect of extending the life of a network. That is, one-third has an average remaining life of 5 years until work is necessary, one-third has an average remaining life of 10 years until work is necessary, and one-third has an average remaining life of 15

years until work is necessary. Overall, the average age of this network is 10 years and 1/3 needs to be replaced every five years.

If we extend the lowest rated 1/3 of system so that it does not need major work for 50 years, the average life of the system is more than doubled. Because of that, the average amount repaired each year is cut in half. Similarly, if we increase that same 1/3 of the network so that it lasts for 40 years, we extend the average life to over 18 years. Even if we only increase the same 1/3 of the system to 25 years, we still increase the systems life by 33% (Figures 3,4,and 5)

## Network Analysis:

### System with only short-life pavements:

Miles in Segment of Highway System	Years to Next Fix	Years of Service in Segments
100	5 (100 x 5)	500 yr-mi
100	10	1000 yr-mi
100	15	1500 yr-mi
		<u>Total = 3000 yr-mi</u>

**Ave. Years of Service for each mile = 3000/300 = 10 yr.**

### If 1/3 of System has long-life pavements:

Miles in Segment of Highway System	Years to Next Fix	Years of Service in Segments
100	5 (100 x 5)	500 yr-mi
100	10	1000 yr-mi
100	50	5000 yr-mi
		<u>Total = 6500 yr-mi</u>

**Ave. Years of Service for each mile = 6500/300 = 21.67 yr.**

**Doubles total service life of system**

Figure 3.

## Network Analysis:

**System with only short-life pavements:**

Miles in Segment of Highway System	Years to Next Fix	Years of Service in Segments
100	5 (100 x 5)	500 yr-mi
100	10	1000 yr-mi
100	15	1500 yr-mi
		<u>Total = 3000 yr-mi</u>

**Ave. Years of Service for each mile = 3000/300 = 10 yr.**

**If 1/3 of System has long-life pavements:**

Miles in Segment of Highway System	Years to Next Fix	Years of Service in Segments
100	5 (100 x 5)	500 yr-mi
100	10	1000 yr-mi
100	40	4000 yr-mi
		<u>Total = 5500 yr-mi</u>

**Ave. Years of Service for each mile = 5500/300 = 18.33 yr.**

Nearly doubles total service life of system

Figure 4.

## Network Analysis:

**System with only short-life pavements:**

Miles in Segment of Highway System	Years to Next Fix	Years of Service in Segments
100	5 (100 x 5)	500 yr-mi
100	10	1000 yr-mi
100	15	1500 yr-mi
		<u>Total = 3000 yr-mi</u>

**Ave. Years of Service for each mile = 3000/300 = 10 yr.**

**If 1/3 of System has long-life pavements:**

Miles in Segment of Highway System	Years to Next Fix	Years of Service in Segments
100	5 (100 x 5)	500 yr-mi
100	10	1000 yr-mi
100	25	2500 yr-mi
		<u>Total = 4000 yr-mi</u>

**Ave. Years of Service for each mile = 4000/300 = 13.33 yr.**

Increases total service life of system by 33%

Figure 5.

**Mix of Fixes**

Mix of fixes is essentially the mix of preservation categories used to repair the existing deficient conditions in a pavement. The 4 basic preservation “mix of fixes” categories are:

- Maintenance
- Restoration (CPR)
- Resurfacing/Rehabilitation (overlays)
- Reconstruction

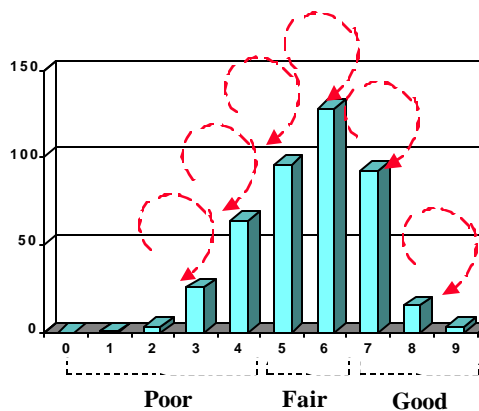
Which one you use depends on the condition of the road and the improvement needed from the repair. Maintenance is used to maintain serviceability and keep the pavement at its current condition. Restoration (CPR) is used to restore pavement integrity by repairing isolated areas of deterioration. This keeps the pavement from falling into a poorer condition. Resurfacing (overlays) are used to improve pavement condition. Finally, reconstruction is used to replace worn out or insufficient pavements or pavements that do not meet modern design standards.

A graphical analysis of an example system and description of each of these preservation categories is shown in the following graphs (Figures 6, 7, 8, and 9) with miles of pavement on the vertical axis and condition ratings of portions of system rated as Poor, Fair, and Good on the horizontal axis.

## Maintenance

Maintenance activities maintain serviceability

- High Benefit, Low User Impact
- Manages Deterioration Rates on “All” Structures
- Delays Category Drop on “All” Pavements



**Figure 6.**

## Restoration

Restoration restores pavement integrity

- Manages Deterioration Rates on “Fair” Pavement
- Delays “Fair” From Becoming “Poor”
- Cost Effective Fixes - Touches More Pavements

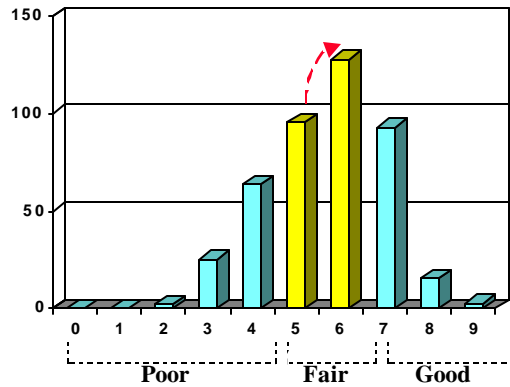


Figure 7.

## Rehabilitation/Overlays

Rehabilitation improves pavement condition

- Improves Condition Ratings
  - “Poor” to “Good”
  - “Poor” to “Fair”
  - “Fair” to “Good”
- Prioritizes Critical Concern Structures

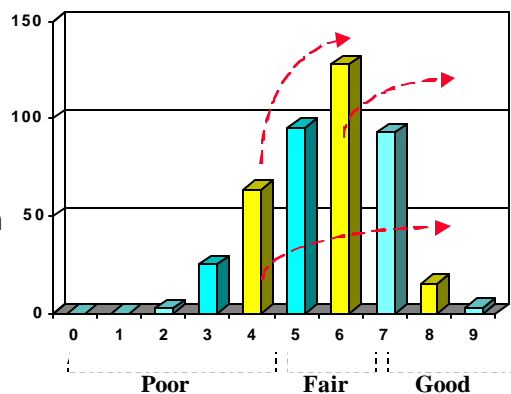
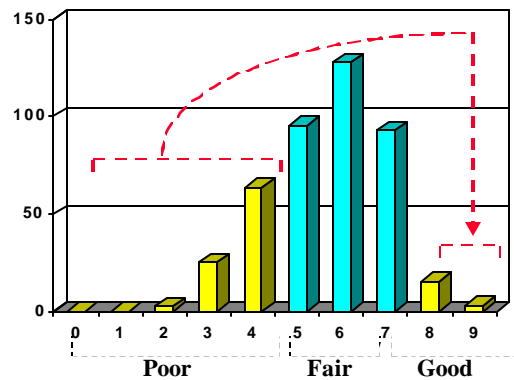


Figure 8.

## Reconstruction

### Replaces pavements

- Address Other Pavement Needs
- Improves Condition Rating – “Poor” to “Good”
- Prioritizes Critical Concern Pavements



**Figure 9.**

Most people believe that concrete pavements rehabilitation options are typically longer-term and only good for heavy duty applications. In reality, there are now many proven concrete “mix of fixes” for preserving, maintaining, and rehabilitating roadways of all classifications, applications, and time frames. The major concrete “mix of fixes” for pavement rehabilitation are:

- Bonded Concrete overlays
- Unbonded Concrete overlays
- Conventional Whitetopping
- Ultra-thin Whitetopping
- Concrete Pavement Restoration (CPR), which includes diamond grinding, full and partial depth repairs, dowel bar retrofit, etc,
- Full depth paving and full-depth reconstruction
- Reconstruction
- Fast Track paving techniques for all options

### Network Impact

Once the average years of remaining service and preservation procedures are known, the engineer must develop a strategy or program of procedures that fills the “structural holes.” A structural hole is a gap in the “Average Years of Remaining Service” chart where there is little or no rehabilitation activities to be done. For example, in Figure 2, there are structural holes in the 13-17, 18-22, and 23-27 remaining years time-frames. The largest structural hole is the time frame beyond the 32 years. Conversely, years 8-

12 is not a structural hole because 30% of the pavements need to be repaired in that period.

The idea is to develop a strategy of preservation activities so that the rehabilitated pavement falls into a structural hole. We do not want to do activities that fall out of a structural hole because then the amount that needs repaired in that period is greatly increased. In our Figure 2 example, an agency does not want to repair the 23% pavements with less than two years remaining with a rehabilitation technique that last 10 years. In it did so, then the agency would have to repair over 50% of its network in the 8-12 year time-frame. Such actions would obviously be extremely difficult and costly to do. In this case, the engineer must chose from his mix of fixes, activities that last between 13 and 27 years, or longer than 32 years.

### **Project Level Life Cycle Cost Analysis**

Once several alternates are chosen to meet the network requirements, the alternates are compared using a Life Cycle Cost Analysis. Life cycle cost analysis is a procedure to do economic comparison of competing alternates considering all significant costs over the economic life of each alternate, expressed in equivalent dollars. It is applied at the project level.

Life cycle cost analysis is normally accomplished to show equivalent dollars as the output by two methods, present worth analysis (PW) or equivalent uniform annual cost analysis (EUAC). The two methods are shown in the following graphical formats (Figures 10 and 11).

# Life-Cycle Cost Analysis

Present Worth Analysis:

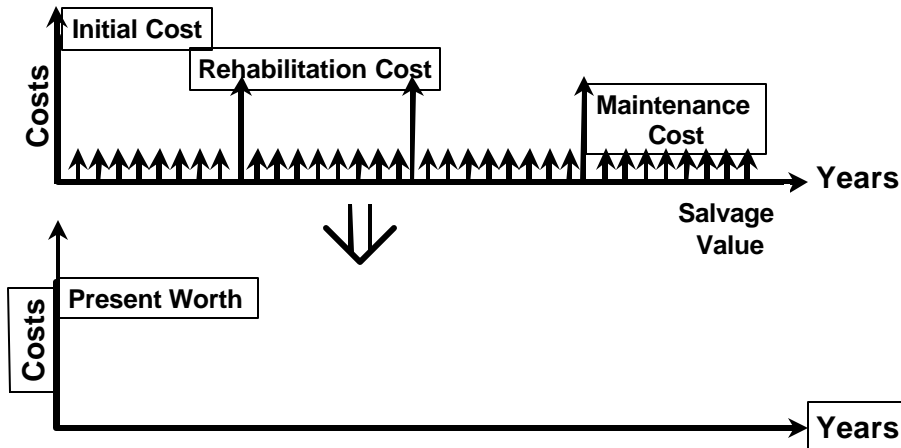


Figure 10.

# Life-Cycle Cost Analysis

Equivalent Uniform Annual Cost:

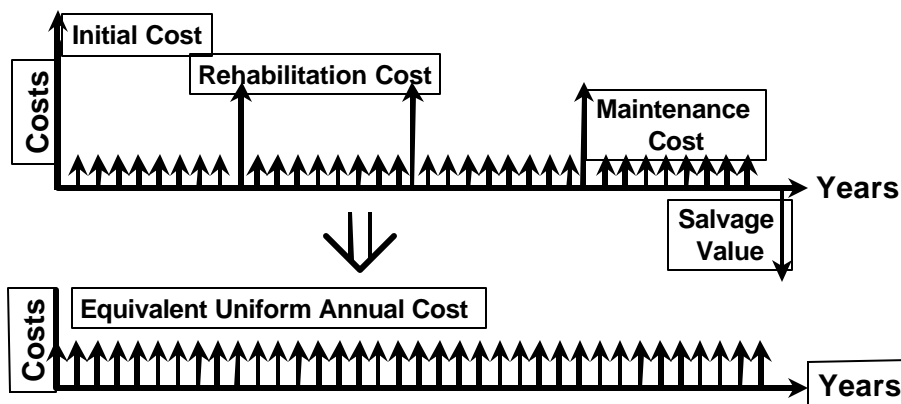


Figure 11.

The basic factors for a comparable life-cycle cost analysis are economic factors and engineering factors. The economic factors are discount rates and analysis periods. The engineering factors are comparable pavement sections, rehabilitation selection, agency costs and user costs. The analysis period should be equal for each alternative. Typical periods are 30-40 years for highways, 20-30 years for streets, and 30 years for airports. At least one rehabilitation event should be included to capture the true economic benefit of each alternative. The agency costs include initial cost of pavement, maintenance and operation cost, anticipated future rehabilitation costs, and salvage/recycling value. The future rehabilitation costs must include engineering, construction, and traffic control to be a realistic representation of true costs.

A summary of the process to complete a LCCA includes (reference FHWA DP 115):

- Design equivalent pavement sections
- Establish strategies for analysis period
  - Estimate agency costs
  - Establish activity timing
  - Develop expenditure streams
- Estimate user costs
- Compute comparative analysis values either present worth or equivalent uniform annual cost
- Analyze results
- Reevaluate strategies

### **Network Comparative Analysis for Asset Management – A Real Life Example**

A recent study was completed on a 40-year history of construction, rehabilitation, and maintenance costs for two comparative counties in the Midwest. County A's network of roadways was a system of primarily concrete with Whitetopping overlays. County B's network of roadways was a system of primarily asphalt with asphalt overlays. The two counties were of comparable size, similar paved mileage, similar traffic, and similar geography. The following graphs (Figures 12 and 13) show that when comparing the construction and maintenance costs on a system wide basis, the use of concrete for new construction and whitetopping resulted in improved performance, decreased unit construction costs and decreased unit maintenance costs. The unit construction costs were 3.3 times more for an asphalt system than concrete system. The unit maintenance costs were 2.1 times more for the asphalt system than concrete system. These actual results show the benefits of using longer-term pavements on the network for asset management.

## Performance Analysis

- Visual distress surveys conducted using MICRO-PAVER
  - PCI values developed for each mile of paved surface
- County A (concrete)
  - 97 = Excellent Category
- County B (asphalt)
  - 84 = Very Good with range Fair, Good, Very Good to Excellent Category

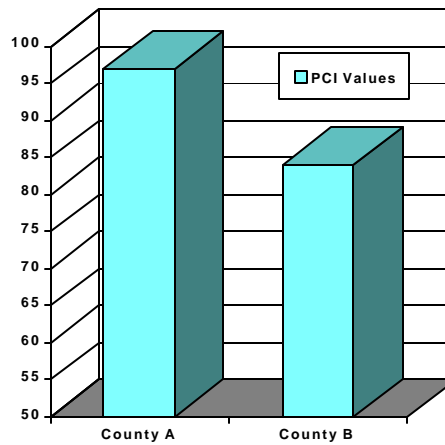


Figure 12.

## Average Pavement Costs

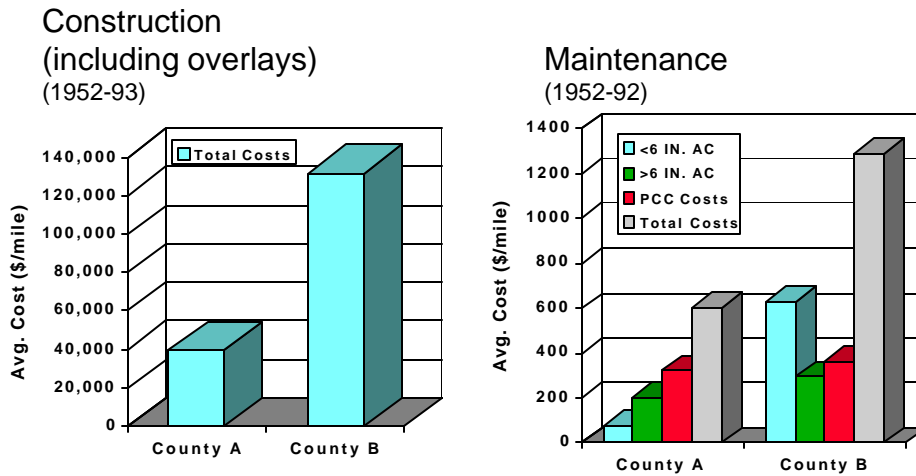


Figure 13.

## Benefits of the Approach

The benefits of this approach affect the network, organization, and customer. Network benefits are a systematic approach to the network that proactively manages deterioration rates to keep the system in a constant condition level. It also leads to a commitment to do the right work at the right time on the entire system so that the established network goals can be met. The benefits to the organization are increased program stability and credibility, coordination with other programs, and organizational commitment over time. The customer benefits include reduced impact to motoring public, increased program stability with resultant confidence in agency, and efficient investment of tax dollars.

## Summary

Asset management is the process of planning, budgeting, and operating functions so the physical assets stay at the highest condition level at the lowest cost possible. For pavements, the idea is to choose the pavement types and the rehabilitation activities that are needed on a network basis so that the flow of dollars into the pavement system are maintained at the lowest, constant level possible; yet maintain the pavement in an acceptable condition.

The approach outlined in this paper includes network and program analysis, continual annual improvement, and progress towards a goal. The ruling premise is that agencies need to look at their existing pavement network and determine its condition and then apply pavement rehabilitation activities that give the performance required to minimize future pavement repairs. Once it is known what is needed on the network level, only then can activities on a project level basis be chosen. Finally, to compare between project level alternatives to find out which are most cost effective, the agency should use life cycle cost analysis.

The concrete industry believes that concrete pavements offer many advantages for positive asset management of streets and local road systems. They are long-term solutions for intersections, arterial streets, collector streets, local streets, new developments (commercial, industrial, and residential), parking lots, and pathways. Essentially all paved surfaces are improved for the longer-term when concrete is used for the surfacing material. Some other reasons include:

- Lower maintenance
- Options for 10-60 year fixes (overlays to full depth)
- Good for budgets with reduced maintenance costs
- Less traffic congestion and disruption – fewer delays (According to a recent Midwest driver survey “drivers believe agencies can and should build longer-lasting pavements with fewer delays.”)
- Handle heavy truck traffic – movement of goods and services

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- ◆ Additional reference information contact American Concrete Pavement Association at 1-87-PAVEMENT or visit the web site at [www.pavement.com](http://www.pavement.com).