A Pavement Preventative Maintenance Program

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The future performance of a highway depends upon the applicability of the applied treatment, application time, and quality of the maintenance it receives. Generally there are three groups of maintenance activities, preventive, routine, and reactive maintenance.

Preventive Maintenance is a planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration and maintains or improves the functional condition of the system without (significantly) increasing structural capacity. An example of a comprehensive pavement preventive maintenance program is identified in Table 1.

Flexible and Composite Pavements	**Rigid Pavements**
Bituminous Crack Treatment (Saw/Route & Seal)	Concrete Joint Resealing
Overband Crack Fill	Concrete Crack Sealing
Chip Seals (Single & Multiple Course)	Concrete Joint & Surface Spall Repair
Micro-Surfacing (Single & Multiple Course)	Dowel Bar Retrofit
Slurry Seal	Partial Depth Concrete Pavement Repair
Cape Seal	Full Depth Concrete Pavement Repair
Fog Seal	Diamond Grinding
Paver Placed Surface Seal (Nova Chip)	Concrete Pavement Restoration
Ultra-Thin Bituminous Overlay (<20mm)	Underdrain Outlet Repair & Cleaning
Bituminous Overlay (<40mm or 1= inch)>	
Profile Milling	
Cold Milling & Bituminous Overlay (<40mm)	
Hot In-Place Bituminous Recycling (<40mm)	
Bituminous Shoulder Work (Remove & Replace)	

Table 1

Routine Maintenance is the day-to-day maintenance activities that are scheduled or whose timing is within the control of maintenance personnel. Examples of routine maintenance activities include mowing and cleaning roadsides, cleaning ditches, sealing cracks in the pavement, painting pavement markings and pruning trees.

Reactive Maintenance are activities that must be done in response to events beyond the control of the highway agency. Examples of reactive maintenance activities include snow plowing, pothole patching, removing and patching pavement blowups, unplugging drainage facilities, replacing a regulatory sign knocked down by traffic, removing tree limbs and branches fallen on the pavement, and responding to a road closing because of flooding. Some events require response as soon as possible to avoid serious consequences because a present or imminent danger exists. Reactive Maintenance cannot be scheduled because they occur without warning and often must be immediately addressed. Frequently, reactive maintenance activities are performed all hours of the day or night and on an overtime basis.

Delays in preventive maintenance increase the quantity and severity of pavement defects and result in higher costs during pavement life. Consequently, using only a routine and reactive approach will considerably increase the life cycle costs of the pavement.

Accepting a preventive maintenance philosophy is the most important factor in successfully managing an agency's pavement program. This philosophy is more difficult to convey than most technical issues, because it requires long-term commitment and financial support from the organizational leadership. Benefits to the highway network are not immediately recognized, and ceremonial events are nonexistent. However, preservation of the highway investment cannot be ignored.

A significant benefit of a comprehensive preventive maintenance program is that it gives managers control over future network conditions and funding requirements, thus fulfilling an important objective of Pavement Management. By controlling future network conditions, decision makers can anticipate routine maintenance work loads, safety deficiencies, and ride quality needs. More important, preventive maintenance affords the manager the capability to achieve maximum benefit from available funds.

Transportation engineers are accustomed to selecting "worst first" highways as candidates for rehabilitation and reconstruction. However, using this criterion for preventive maintenance can lead to disastrous results. Although it is understood that periodic inexpensive treatments are more economical than infrequent high cost treatments, engineers must recognize causes of pavement deterioration, and apply correct treatments at appropriate times during the pavement life. This is best illustrated by Figure 1 and Figure 2. Both figures display a diagonal line on a graph, representing normal pavement distress accumulating over time. A distress value between zero points and 50 points, measure a pavement in satisfactory condition. Distress values more than 50 points, measures a pavement in unsatisfactory condition. Figure 1 shows the results when preventive maintenance is applied to a pavement in unsatisfactory condition. Figure 2 shows the results when a preventive maintenance treatment is applied early, to a pavement in satisfactory condition. Compare the shaded area from both graphs. The shaded area represents the improvement to the pavement condition over the treatment life. Pavements that have treatments applied when severely distressed received little benefit. However, treatments applied to pavements with light to moderate distress provides substantial benefit by extending the pavement life.

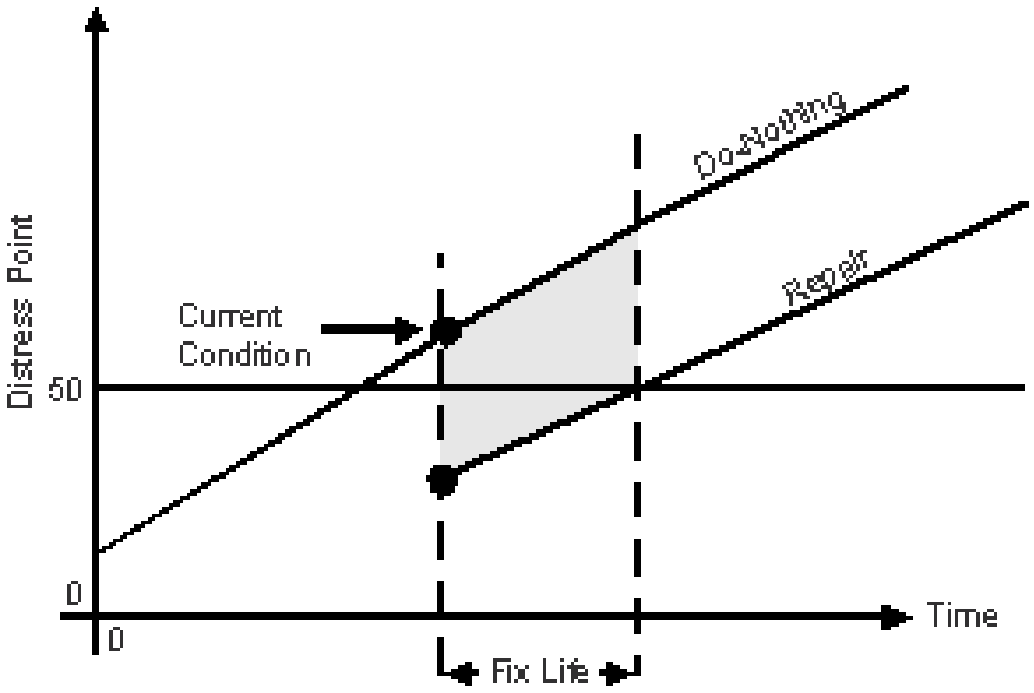

Figure 1

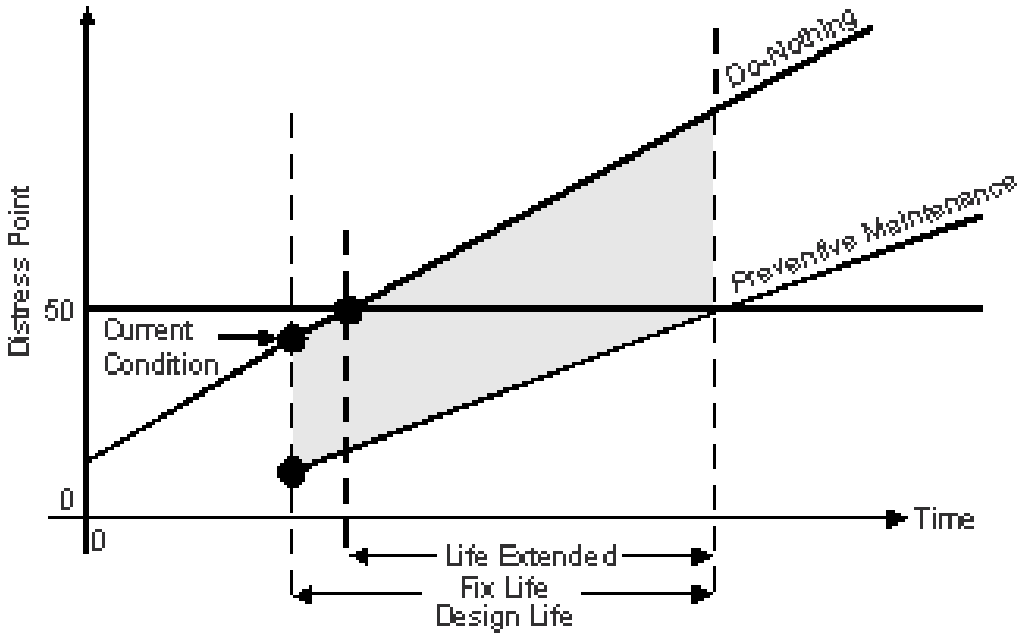

Figure 2

When a preventive maintenance strategy is applied to a highway network, a management tool is created to optimize future resource allocations. In the past, the total network condition generally suffered due to funding demands of reconstruction projects. Now by designating a portion of funding to preventive maintenance, managers have the ability to enhance the network with major rehabilitation and reconstruction projects without jeopardizing the overall surface condition of the highways. This logic is best illustrated by reviewing Figure 3. The bar chart plots the pavement remaining life of a typical highway network that failed to implement preventive maintenance. The unequal distribution of pavement remaining life, displayed by the "chimney" bars, represents a significant problem in time. The problem becomes more evident with time as the "chimney" approaches zero remaining life. With no remaining life the pavement is a candidate for rehabilitation and reconstruction. Reacting to large surges in construction can be devastating to all involved in the process. First, large fluctuations in funding are necessary, a concept not popular with the public. Second, variation in the construction activities from year to year, create staffing problems for the highway agency and the contractor. Hiring and firing personnel to accommodate changing workloads will hurt the employee and is bad for the organization. Finally, contractors and suppliers need a stable source of work to survive in the marketplace. Years with heavy workloads followed by years with light workloads will force many contractors out of business.

A strategy that incorporates preventive maintenance can significantly alter the distribution of pavement remaining life. By targeting large concentrations of pavements with similar remaining lives, preventive maintenance treatments can be used to equalize projected workloads long before problems develop. This action is displayed graphically in Figure 4. Creating a network equilibrium of remaining life will insure manageable workloads for available revenues.

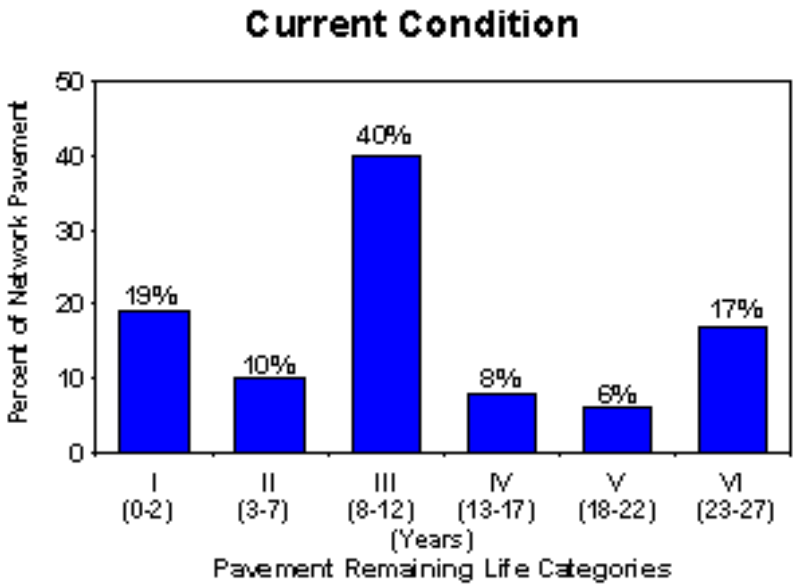

Figure 3

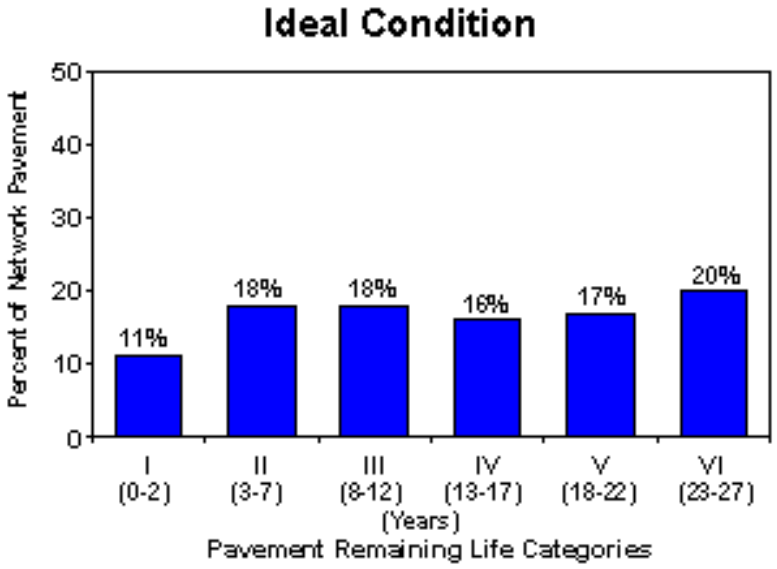

Figure 4

The best strategy, giving greatest flexibility to the highway agency, is implementing a three-tier program of reconstruction, rehabilitation, and preventive maintenance. This approach allows the agency to address the worst highways through reconstruction, improve poor highways by rehabilitation, and preserve the good highways with timely preventive maintenance. Reconstruction programs achieve long term performance enhancements which are most desirable to the traveling public. But after considering the high cost of reconstruction projects, most highway agencies cannot sustain this course with limited budgets. The consequence of using a long-term reconstruction strategy without a rehabilitation program and a preventive maintenance program is best illustrated in Figure 5. The funding in the example is constant, but adjusted for inflation.

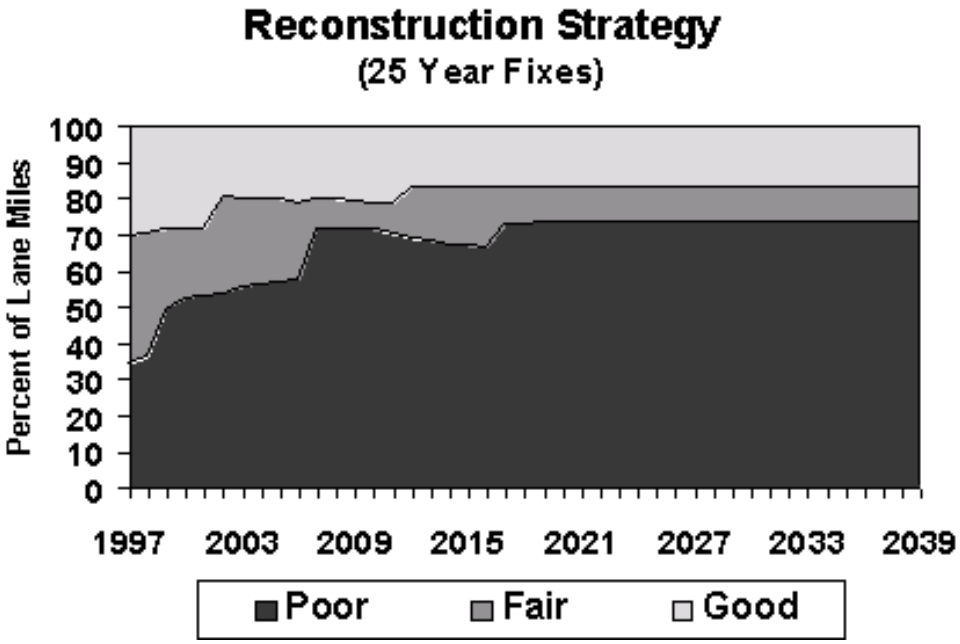

Figure 5

Rehabilitation programs increase pavement performance for approximately ten to twenty years with lower costs than reconstruction projects. Rehabilitation activities alone cannot improve the network longevity with agency funding constraints. When a combined reconstruction and rehabilitation strategy is implemented the results are still not optimal as illustrated in Figure 6.

Preventive maintenance programs are designed to extend the life of good pavements by applying low cost, short term treatments. The benefit of preventive maintenance activity can only be realized if the agency applies treatments to pavements in good condition. Thus, combining all three programs into a single strategy achieves the greatest benefit for the highway network. The result of a combined strategy is shown in Figure 7. The funding in Figure 7 is identical to that of Figure 5 and Figure 6.

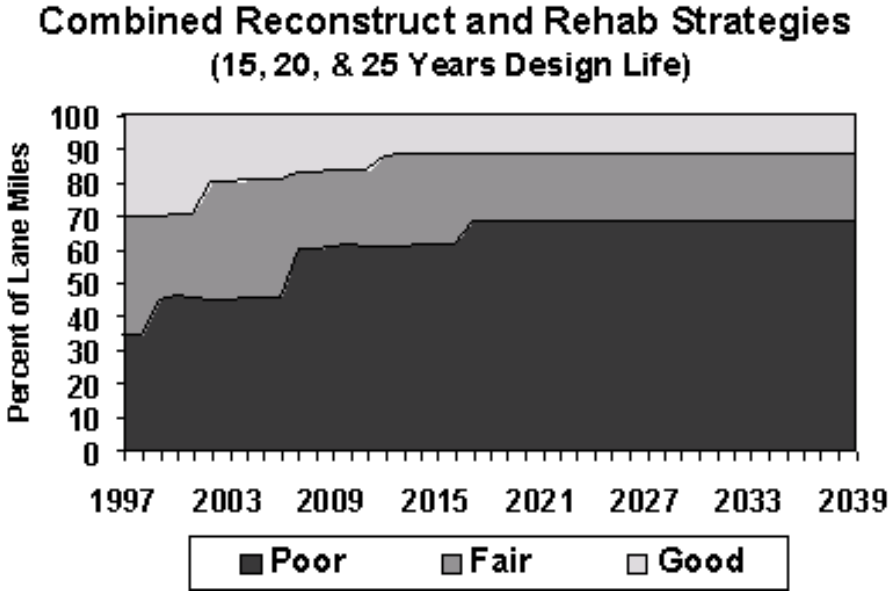

Figure 6

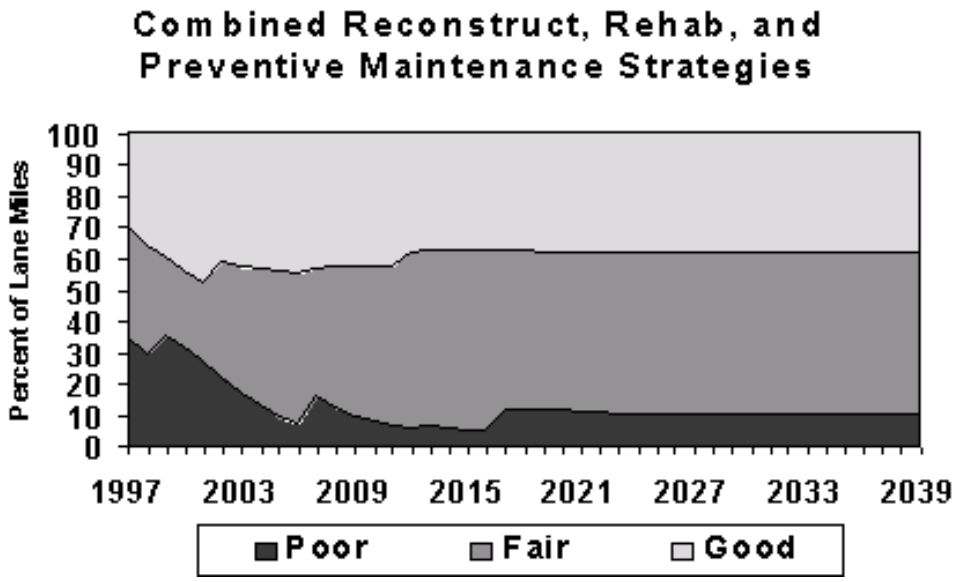

Figure 7

Preventive maintenance, is perhaps the single most influential component in the network strategy, that allows an agency to manage pavement conditions. It creates the ability to postpone costly reconstruction or rehabilitation activities, by extending the remaining service life of the original pavement. The real challenge for most agencies is to ascertain when in the life of a pavement is the best time to apply a preventive maintenance treatment for the maximum benefit.

Summary

Many factors should be carefully considered prior to the formulation of a preventive maintenance program. Implementation of the following strategies should be encouraged to be successful:

- Promote an understanding and acceptance of the preventive maintenance philosophy in the organization.
- Select pavements in good condition to apply preventive maintenance treatments.
- Obtain the support and financial commitment from the organization leadership.
- Recognize opportunities to simplify the business process with preventive maintenance projects.
- Modify specifications to give contractors a greater role in quality control.
- Adopt a comprehensive program using many different treatments to address various pavement deficiencies.
- Develop written guidelines for preventive maintenance to insure uniformity and correct treatment selection.
- Use Pavement Management as a resource to support a preventive maintenance initiative.
- Monitor performance of preventive maintenance treatments on an annual basis.