Chapter 7

Pavement Management

PAVEMENT MANAGEMENT CONCEPTS

Historically, small agencies have developed an informal process for managing pavement. Pavements are examined periodically and the worst ones are repaired, rehabilitated, or reconstructed. At times, individuals with clout bring pressure to bear to repair a particular street or road. Through the years, this informal process has worked because the knowledge, experience, and common sense of those in decision making positions led to logical street and highway programs.

Today, however, as traffic volumes and vehicle loadings increasingly burden pavements, local governments' maintenance budgets have not kept pace with the rising costs of labor, materials, and equipment. Because local agencies today are faced with increasing economic demands, a more systematic process is needed to justify and account for pavement maintenance expenditures.

More and more agencies are adopting a pavement management program that will answer the following questions:

1. How does one determine what pavement is "worst"?
2. When is the best time to schedule repair, resealing, or resurfacing?
3. What is the savings or cost of deferring repairs?
4. What is the most cost-effective action to take in repair or restoration?

Pavement management can be defined as *an orderly process for providing, operating, maintaining, repairing, and restoring a network of pavements.*

The decision to repair or rehabilitate is complicated because of the variety of types of pavement distress – some serious and others relatively minor. If pavements with some serious levels of distress are not rehabilitated in an expedient manner, their ultimate repair may be significantly more expensive. An overlay made at the proper time in the life of a pavement, for example, may extend the life for many years. If not overlayed, the same pavement may require complete reconstruction.

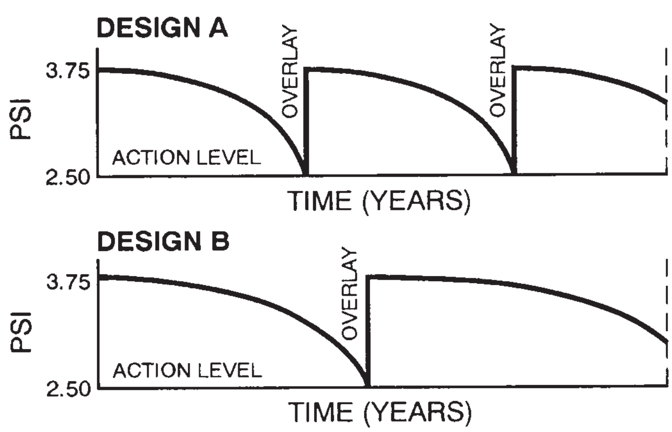


Figure 7-1.

Carrying out a pavement management program involves the development of a recordkeeping strategy with the appropriate forms. The procedures can be relatively simple or very complex depending on the size of the agency. Complex and costly computer operations are used in large jurisdictions. In the case of a smaller street or road network, there are a number of microcomputer programs available from consultants, or through public agencies. Iowa State University Extension's Local Transportation Information Center offers workshops on the subject.

The Asphalt Institute has developed A Pavement Rating System for Low-Volume Asphalt Roads. Information about its system is contained in Information Series No. 169 (IS-169). The subject also is covered in some detail in The Asphalt Handbook manual series No. 4 (MS-4).

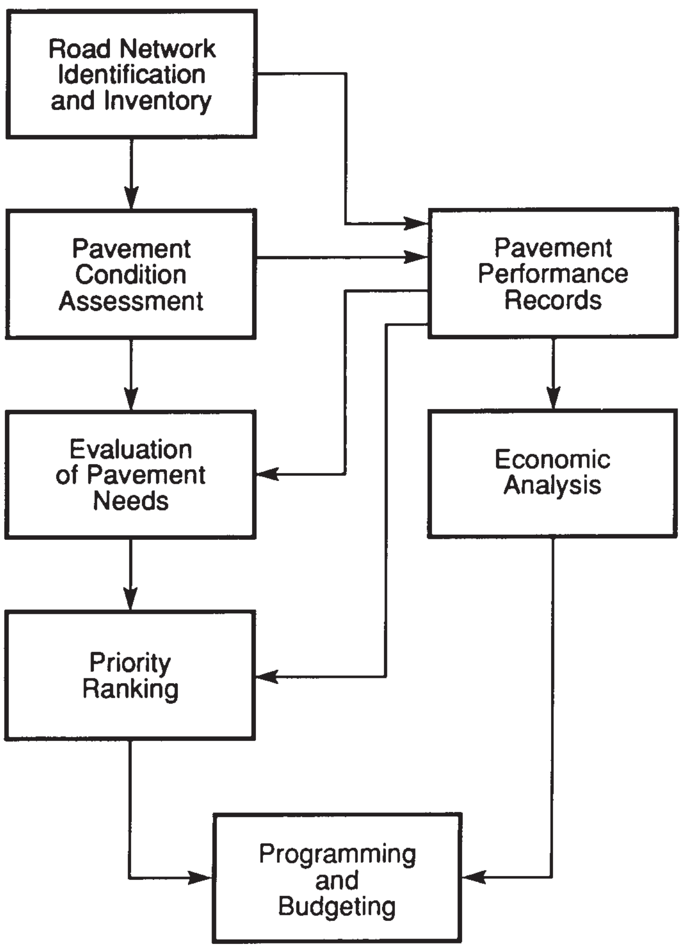


Figure 7-2.

Rating a Road

The Asphalt Institute's publication provides a system for any individual or agency to inspect a road, rate it, and interpret the results. All that is needed is an individual or individuals with maintenance knowledge - such as a superintendent or foreman - to walk the road and assign a numerical value to each type of pavement defect. The type of distress, the extent of the distress, and its relative seriousness must be recorded.

In this procedure, lower values are assigned to less serious problems and higher values to more serious problems. A rating of zero indicates that the pavement is relatively free of defects. A rating of 5 or 10 would indicate serious distress. After each defect has been rated, the individual ratings are added. The sum is then subtracted from 100 and the result is a condition rating for that particular piece of road.

It is important that pavements are evaluated in a consistent manner. Those conducting a condition rating survey must have knowledge of the various types of defects, their cause, and the remedial action required. A guide for identifying and correcting pavement failures is included in Appendix A of this Design Guide. Additional detailed information on this subject is available in The Asphalt Institute's publications (MS-16), (MS-17), (MS-4), and others.

Interpretation of a Condition Rating

The absolute value assigned by the condition rating provides an indicator of the type and degree of repair work necessary. As a general rule, if the condition rating is between 80 and 100, normal maintenance operations (crackfilling, pothole repair, or seal coat) are all that are required. If the condition falls below 80, it is likely that an overlay will be necessary. If the condition rating is below 30, major reconstruction may be necessary.

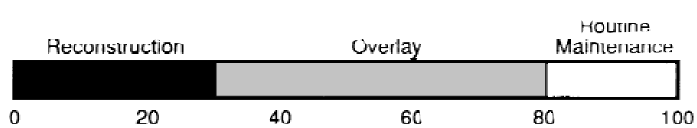


Figure 7-3

Another valuable use for the condition rating is to provide a rational method for ranking roads and streets according to their condition. A priority ranking should be the basis for programming and budgeting maintenance, rehabilitation, and reconstruction.

ASPHALT PAVEMENT RATING FORM

STREET OR ROUTE __________________________ CITY OR COUNTY ______________

LENGTH OF PROJECT _______________________ WIDTH ________________________

PAVEMENT TYPE ___________________________ DATE _________________________

(Note: A rating of "0" indicates defect does not occur)

DEFECTS		RATING
Transverse Cracks	0-5	_______
Longitudinal Cracks	0-5	_______
Alligator Cracks	0-10	_______
Shrinkage Cracks	0-5	_______
Rutting	0-10	_______
Corrugations	0-5	_______
Raveling	0-5	_______
Shoving or Pushing	0-10	_______
Pot Holes	0-10	_______
Excess Asphalt	0-10	_______
Polished Aggregate	0-5	_______
Deficient Drainage	0-10	_______
Overall Riding Quality (0 is excellent; 10 is very poor)	0-10	_______
	Sum of Defects	_______

Condition Rating = 100 - Sum of Defects

= 100 - ______________

Condition Rating = [ ]

Figure 7-4. Asphalt pavement rating form

PAVEMENT MAINTAINENCE

Pavement maintenance is the routine work performed to keep a pavement, which is exposed to normal conditions of traffic and nature, as near to its original condition as possible. Because destructive environmental and traffic forces are constantly at work, all pavements require maintenance. Cracks, holes, depressions, and other types of distress are the visible evidence of pavement wear. In urban areas, utility cuts and repairs are major contributors to the need for pavement maintenance.

Taking care of pavement deterioration at the proper time and in the proper manner can significantly increase the life of the pavement. Early detection and repair of minor defects are among the most important activities of road maintenance crews. In their first stages, cracks and other surface breaks are almost unnoticeable, but they may develop into serious defects if not soon repaired. Open joints and cracks allow water to enter the subgrade and lead to pumping and faulting with resultant structural failure. It has been estimated that on rural pavements in Iowa, 70 percent of the

subgrade moisture originates at the edge of the pavements.

Pavement maintenance involves the identification of pavement distress types and the determination of appropriate maintenance activities. The following sections provide information on full-depth patching, thin overlays, and overlays. In addition, a section on identifying and correcting pavement failures is included in Appendix A.

Full-Depth Asphalt Patching

The full-depth asphalt patch is an important maintenance technique for protecting and preserving the sizable investment in roads. It is used to repair all types of localized pavement distress that extend below the roadway surface. Examples include potholes, alligator cracking, upheaval, and shoving.

Simply stated, the procedure is to remove the failed area and replace it with fresh asphalt mix. Although the operation is not difficult, some of the necessary fine points are frequently not given sufficient attention. Yet these details often determine whether the completed patch will be a temporary expedient or an integral part of a functional pavement system.

The following illustration outlines the correct procedure for constructing a full-depth patch:

1. Untreated pothole.
2. Surface and base removed to firm support.
3. Tack coat applied.
4. Full-depth asphalt mixture placed and being compacted.
5. Finished patch compacted to level of surrounding pavement.

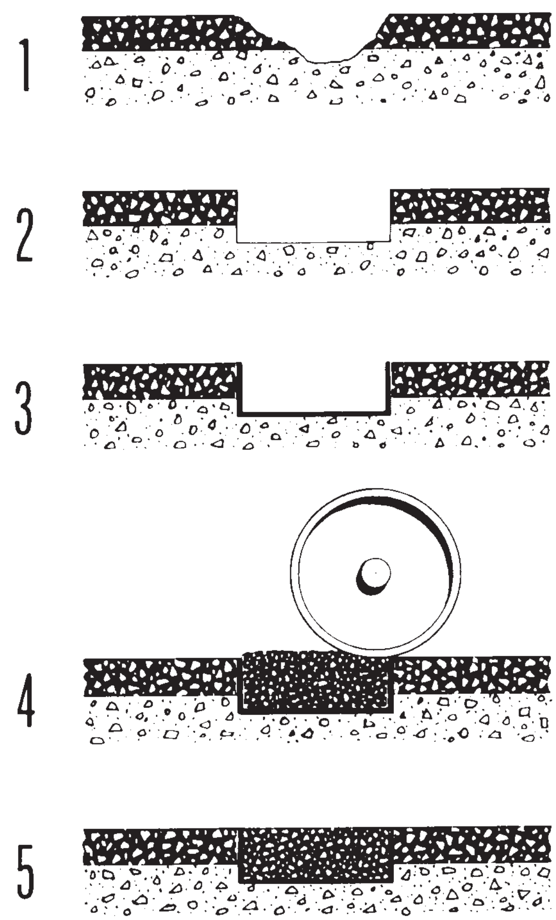
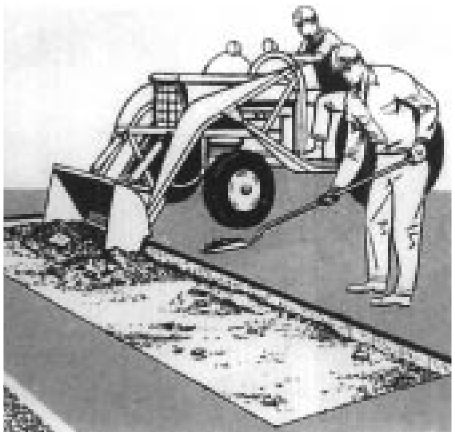


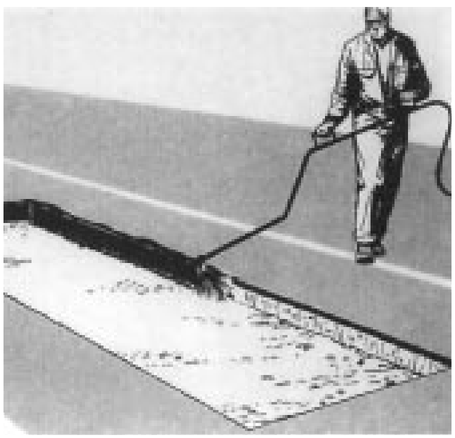
Figure 7-5.

Constructing the Patch



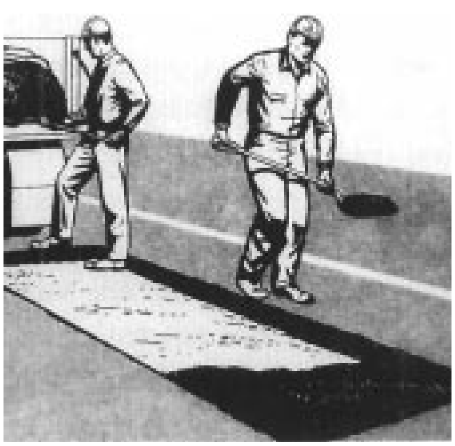
Removing Surface & Base

- With a pavement saw or pneumatic hammer, cut the outline of the patch, extending at least 1 foot outside of the distressed area. The outline should be square or rectangular with two of the sides at right angles to the direction of traffic.
- Excavate as much pavement as necessary to reach firm support. If a patch is to be an integral part of the pavement, its foundation must be as strong or stronger than that of the original roadway. This may mean that some of the subgrade will also have to be removed. The faces of the excavation should be straight and vertical.
- Trim and compact the subgrade.



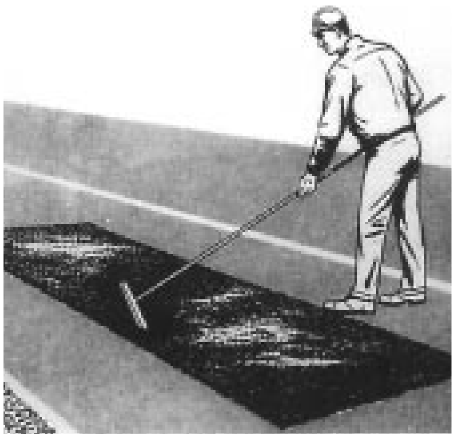
Applying Tack Coat

- Apply a tack coat to the vertical faces of the excavation. Emulsified asphalts or liquid asphalt are all suitable.



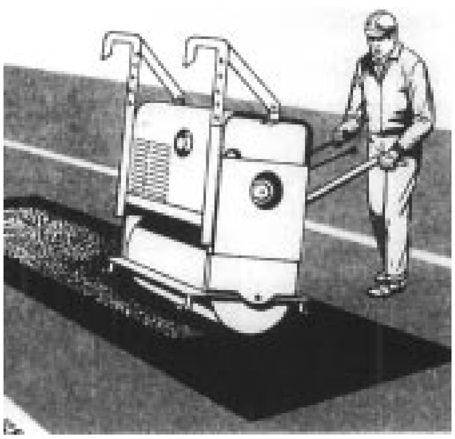
Backfilling Holes with Plant Mix

- Backfill with the asphalt mixture. Shovel the mixture directly from the truck into the prepared excavation. Place the mixture against the edges of the hole first (rather than in the center and then raking to the edges). The maximum lift thickness largely depends upon the type of asphalt mixture and the available compaction equipment. Hot mix asphalt can and should be placed in deep lifts, because the greater heat retention of the thicker layers facilitates compaction. From a compaction standpoint, patches using hot mix asphalt can be backfilled in one lift. However, when placing a patch that is deeper than 5 inches, it is often useful to leave the first lift 1 to 2 inches below the finished grade, making it easier to judge the total quantity of mixture required for the patch.



Spreading the Mix

- Spread carefully to avoid segregation of the mixture. Avoid pulling the material from the center of the patch to the edges. If more material is needed at the edge, it should be deposited there and the excess raked away. The amount of mixture used should be sufficient to ensure that after compaction, the patch surface will not be below that of the adjacent pavement. On the other hand, if too much material is used, a hump will result.



Compacting the Mix

- Compact each lift of the patch thoroughly. Use equipment that is suited for the size of the job. A vibratory plate compactor is excellent for small jobs, while a vibratory roller is likely to be more effective for larger areas.

- When compacting the final lift (which may be the only lift), overlap the first pass and return of the vibratory roller or plate compactor no more than 6 inches on the patch on one side. Then move to the opposite side and repeat the process. Once this is accomplished, proceed at right angles to the compacted edges with each pass and return, overlapping a few inches on the uncompacted mix. If there is a grade, compaction should proceed from the low side to the high side to minimize possible shoving of the mix.

- When adequate compaction equipment is used, the surface of the patch should be at the same elevation as the surrounding pavement. However, if hand tamping or other light compaction methods are used, the surface of the completed patch should be slightly higher than the adjacent pavement because the patch is likely to be further compressed by traffic.

Straightedging the Patch

- Check the vertical alignment and smoothness of the patch with a straight edge or stringline.

Thin Surface Treatments

Asphalt surface treatment is a broad term embracing several types of asphalt and asphalt aggregate applications, which are usually less than 1 inch thick and can be applied to any kind of road surface. The road surface may be a primed granular base or similar surface, or it may be an existing pavement. Surface treatments applied to an existing pavement surface often are called seal coats.

This chapter covers surface treatments consisting of asphalt emulsion-aggregate applications only. Because surface treatments and seal coats differ in name only for this type of construction, they are treated as a single subject.

A single surface treatment involves spraying asphalt emulsion, which is immediately followed by application of a thin aggregate cover that is rolled as soon as possible. For multiple surface treatments, the aggregate cover process is repeated two or even three times, with the aggregate size becoming smaller with each application. The maximum size aggregate for each successive application is about one-half that of the previous one. The total thickness of the treatment is about the same as the maximum size aggregate particles of the first course.

Properly constructed, asphalt surface treatments are economical, easy to place, and effective. They seal and add life to road surfaces. However, each type has one or more special purposes. A surface treatment is not actually pavement. Rather, it resists traffic abrasion and provides a waterproof cover over the underlying structure. It adds little load-carrying strength and therefore is not normally taken into account when computing the load limit of a pavement. While a surface treatment can provide an excellent surface if used for the correct purpose, it is not a cure-all for all paving problems. A clear understanding of the advantage and limitations of asphalt-emulsion surface treatments is essential to ensure best results. It is vital to make a careful study of traffic requirements and an evaluation of the condition of existing materials and pavement layers.

Single Surface Treatment

A single surface treatment, often called a "seal coat," involves spraying asphalt emulsion followed at once by a thin aggregate cover. This cover is rolled as soon as possible after laying.

When the aggregate is compacted to its densest position, the voids between aggregates are filled about two-thirds to three-fourths full with asphalt. A typical design will call for 70 percent of the voids to be filled. A full outline of materials and procedures can be found in Section 2307 of the IHD Standard Specifications. Application rates are given in Table 7-1.

Table 7-1. Surface Treatment Application Rates

	Asphalt Emulsion		
Aggregate Size	Spreading Rate Gallons/Sq. Yd.	Basic Rate Gallons/Sq. Yd.	Aggregate Spreading Rate Pounds/Sq. Yd.
Sand	0.15-0.20	0.15	10-15
3/8 inch	0.25-0.35	0.30	20-25
1/2 inch	0.35-0.45	0.40	25-30

A single surface treatment or seal coat may be used for one of several reasons:

1. As an interim measure pending application of a higher pavement type.
2. To correct surface raveling and oxidation of old pavements.
3. To provide a waterproof cover over an existing pavement structure.
4. To correct excessive traffic wear beyond that presumed in the original design.

The single treatment approach is especially well-suited for light-duty traffic and as an interim maintenance procedure. It also may be used following crack sealing operations. The surface treatment is applied to resist the abrasive forces of the traffic.

Problems that can be associated with a treatment of this type include:

1. Construction during cool weather. It usually requires about one month of warm weather following construction for the aggregate particles to become reoriented and properly embedded in the asphalt membrane.

2. Possible loss of cover aggregate may occur because of the relatively thin layer and the time required for embedding and bonding to develop. In single treatments the larger aggregate particles are more prone to be lost.

Multiple Surface Treatment

A multiple surface treatment can produce a pavement thickness in the range of 1/2 to 3/4 inch. Some extra reinforcement may be added with this type of treatment. If properly designed and constructed, double surface treatments give about three times the service life of a single surface treatment for about one and one-half times the construction cost. Because the cover stone for the second layer is smaller, loss of particles from a graded cover aggregate is greatly minimized.

In a double surface treatment, the largest size of stone in the first course determines the surface layer thickness. The second course serves to fill the voids in the mat of the first course aggregate. The extent to which these voids are filled determines the texture and riding quality of the surface treatment.

Sand Seal

Sand seal is defined as a spray application of asphalt emulsion followed by a light covering of fine aggregate, such as clean sand or screenings. Although this is a rather simple operation, it can be useful in correcting a number of pavement flaws. The procedure involves an emulsion spray application. Usually emulsion grades RS-1, CRS-1, or HFMS-1 are used at a rate of about 0.15 to 0.20 gallons per square yard. This is followed by about 10 to 15 gallons per square yard of sand or screenings cover.

The sand seal is used primarily for the following purposes:

- To enrich a dry, weathered, or oxidized surface. The sand seal will help prevent loss of material from the old surface by traffic abrasion.

- To prevent the intrusion of moisture and air. When an existing pavement surface begins to crack, moisture and air pass into the underlying pavement structure, reducing its load-carrying ability. A sand seal can provide a barrier to prevent this intrusion.

- To develop a skid-resistant surface texture. By selecting a sharp, angular, fine aggregate, a highly skid-resistant surface can be provided. The sand may also be used to "soak up" spots of asphalt that have appeared on the surface because of an overly rich condition.

Slurry Seal

A slurry seal is a mixture of well-graded fine aggregate, mineral filler (if needed), emulsified asphalt, and water applied to a pavement as a surface treatment. It is used in both the preventive and corrective maintenance of asphalt pavement surfaces. It does not, nor is it intended to, increase the structural strength of a pavement section. Any pavement that is structurally weak in localized areas should be repaired before applying the slurry seal. All ruts, humps, low pavement edges, crown deficiencies, waves, or other surface irregularities that diminish the riding quality should be corrected before placing the slurry seal.

When applied to the surface of an older pavement, slurry seal can be used quite effectively. It will seal the surface cracks, stop raveling and loss of matrix, make open surfaces impermeable to air and water, and improve skid resistance. Its timely application will help reduce surface distress caused by oxidation of the asphalt and embrittlement of the paving mixture.

Slurry seal offers the following advantages:

- Rapid application.
- No loose cover aggregate.
- Excellent surface texture for paint striping.
- Ability to correct minor surface irregularities.
- Minimum loss of curb height.
- No need for manhole and other structural adjustments.
- In many cases, the relatively low cost of the treatment makes it practical to import aggregates for special effects, such as high-skid resistance, color contrast, and noise reduction.
- Resists degrading effect of oil and gasoline dripped from cars.

ASPHALT CONCRETE OVERLAYS

Asphalt Concrete is an excellent resurfacing material that is equally effective for overlaying asphalt/aggregate surfaces, existing Asphalt Concrete pavements, or Portland cement pavements. Asphalt overlays add strength to an old pavement structure, extend service life, and provide a smooth, skid-resistant pavement. They improve riding quality and the cross section, and they increase a pavement's resistance to water intrusion and deicing chemicals. The result is a better riding surface and stronger pavement than the original.

Advantages

A Asphalt Concrete overlay offers the following advantages:

1. Convenience. The pavement may remain in use while it is being upgraded.

2. Economy. An old pavement frequently may be improved and returned to service more quickly and for less cost than a new road can be constructed.

3. Durability. Well-designed, well-constructed improvements provide a pavement that is stronger than new, which reduces maintenance requirements.

Design Considerations

Before constructing a Asphalt Concrete overlay, careful and correct preparation of the existing pavement is essential for maximum pavement performance. Each resurfacing project must be designed on an individual basis.

Local Repairs

All weak areas should be repaired. Structural patches should be designed and constructed with full-depth Asphalt Concrete to ensure strength equal to or exceeding that of the surrounding pavement. Carefully placed and adequately compacted patches will produce uniform support for the overlay and ensure good performance.

Structural Deficiencies

Pavement deficiencies that do not affect structural adequacy are usually corrected by thin resurfacings using thicknesses selected from experience.

Weakened pavement structures call for overlays of designed thicknesses that will sufficiently strengthen the pavement structure to accommodate the traffic expected to use it.

Drainage

Older pavements may show signs of fatigue because of intrusion of groundwater from below or from surface water entering along the edge between pavement and shoulder. This water should be removed by underdrains or by other means several weeks before constructing the asphalt overlay.

Leveling

When the surface is distorted, the construction of leveling courses or wedges is required to restore proper line and cross section.

Overlay Thickness

Asphalt Concrete overlays may be used to correct both surface and structural deficiencies. Present pavement condition and estimates of future traffic influence appropriate thicknesses of these overlays. A 1-inch average depth of Asphalt Concrete surface should be the minimum thickness. As a standard rule, the lift thickness should be at least twice the maximum aggregate size in the mixture.

Overlay Thickness Calculations

How thick should the overlay be? Two publications available from The Asphalt Institute can aid in the calculations. The first, for roads and streets carrying up to 100 heavy trucks per day, is <u>A Simplified Method for The Design of Asphalt Overlays for Light to Medium Traffic Pavements</u> (IS-139).

The second procedure, for overlays on roads and streets carrying more than 100 heavy trucks per day, is detailed in The Asphalt Institute's manual, <u>Asphalt Overlays for Highway and Street Rehabilitation</u> (MS17).

When the majority of the heavy trucks have a gross weight of more than 60,000 pounds, these simplified overlay design methods should not be used.

The following steps and tables may be used to determine overlay thickness needs.

- Using the estimated average number of heavy trucks per day, and the assigned subgrade category, determine the required thickness of full-depth asphalt pavement required using the appropriate table.

- Also, determine the effective thickness of the existing pavement as if it were converted to full-depth Asphalt Concrete. Each individual course of the existing pavement is evaluated, using the appropriate table, to determine its equivalent thickness of Asphalt Concrete pavement; the sum is the effective thickness.

- The thickness of the Asphalt Concrete overlay required is equal to the required thickness determined in Step 1 minus the effective thickness of the existing pavement determined in Step 2.

Table 7-2
FACTORS EMPLOYED TO CONVERT EXISTING COURSES TO EQUIVALENT THICKNESS OF FULL-DEPTH ASPHALT CONCRETE

Pavement Course	Minimum Requirements	Factor
ASPHALT CONCRETE	Stable, generally uncracked with little or no deformation in the wheel paths	0.9- 1.0
	Stable, some fine cracking or slight deformation in the wheel paths	0.7 - 0.9
	Appreciable cracking and crack patterns, or appreciable deformation in the wheel paths	0.5 - 0.7
EMULSIFIED OR CUTBACK ASPHALT MIXTURES	Stable, generally uncracked and exhibiting little deformationin the wheel paths	0.7 - 0.9
	Stable, some fine cracking, some raveling or aggregate degradation, and slight deformation in the wheel paths	0.5 - 0.7
	Extensive cracking, considerableraveling or aggregate degradation, appreciable deformation in the wheel paths and lack of stability	0.3 - 0.5
PORTLAND CEMENT CONCRETE	Stable, undersealed and generally uncracked	0.9 -1.0
	Stable, undersealed, some cracks but no pieces smaller than about one square metre (yard)	0.7 - 0.9
	Appreciably cracked and faulted, cannot be undersealed. Slab fragments, ranging in size from approximately one to four square metres (yards) have been well-seated on the subgrade by heavy pneumatic rolling	0.5 - 0.7
	Pavement broken into small pieces, 0.6m (2 ft) or less in maximum dimension. Use upper part of range when subbase is present; lower part of range when slab is on subgrade	0.3 - 0.5
AGGREGATE	Granular subbase or base – reasonably well-graded, hard aggregates with some plastic fines and CBR not less than 20. Use upper part of range if P.I. is 6 or less; lower part of range if P.I. is more than 6	0.1 - 0.2
SOIL	Improved subgrade or native subgrade, in all cases	0

Table 7-3. Typical Thickness of Full-Depth Asphalt Concrete For Light to Moderate Traffic Roads

Traffic Class	Subgrade Class (CBR)		
	Poor (3)	Moderate (6)	Good (9)
I	6.0	4.5	4.0
II	7.0	6.0	5.0
III	7.5	6.5	5.5
IV	9.5	8.5	7.5
V	12.0	11.0	10.0

Adequate preparation of the existing pavement prior to an asphalt overlay is important. When repairs are completed, the surface to be overlaid must be thoroughly cleaned. Then a tack coat of asphalt must be applied to ensure uniform and complete adherence of the overlay.

As discussed earlier under pavement management concepts, the condition rating provides a rational method for evaluating the need for an overlay. If the condition rating falls below 80, it probably calls for an overlay. Deferring the overlay allows further deterioration of the pavement. At some point in time, the life of the pavement is severely affected, which will increase costs significantly.

The predictive capabilities of a pavement management system allow an agency to analyze alternative programs and select a maintenance strategy that is cost effective. Deferred maintenance is more costly in the long run as illustrated by the quality of deterioration over time example.

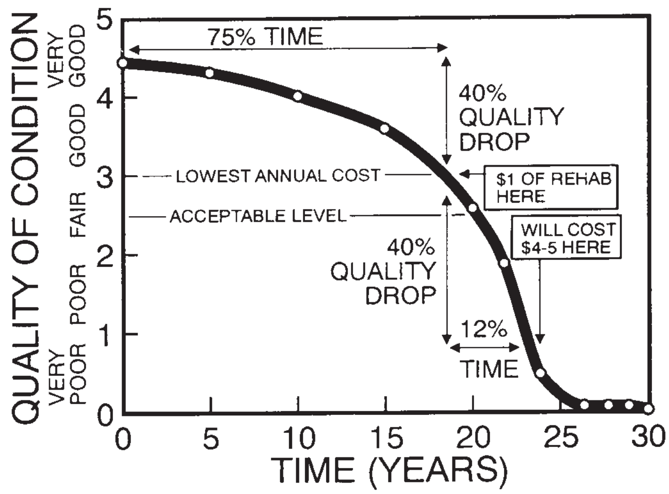


Figure 7-7.

Table 7-4. Typical Overlay Thickness (Inches) For Local Roads, Residential Streets, and Collectors

Subgrade Type	Condition Rating Local and Residential Streets			
	<25	25-50	<25	25-50
Local Roads and Residential Streets				
	<200 ADT		>200 ADT	
Good	1	-	1.5	1
Medium	1.5	1	2	1.5
Poor	2	1	2.5	2
Collector Roads and Streets				
	<1,500 ADT		>1,500 ADT	
Good	2	1.5	2.5	2
Medium	2.5	2	3	2.5
Poor	3	2.5	3.5	3

For a discussion on the condition rating procedure for this particular table see the Pavement Management section.