Information Series 129

NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION

A Guideline for the Design and Construction of

HMA Pavements for Trails and Paths

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This publication is provided by the members of the National Asphalt Pavement Association (NAPA), who are the nation's leading Hot Mix Asphalt (HMA) producer/contractor firms and those furnishing equipment and services for the construction of quality HMA pavements.

NAPA Members are dedicated to providing the highest quality HMA paving materials and pavements, and to increasing the knowledge of quality HMA pavement design, construction, maintenance and rehabilitation. NAPA also strongly supports the development and dissemination of research, engineering and educational information that meets America's needs in transportation, recreational and environmental pavements.

This publication is designed to provide information of interest to NAPA members and is not to be considered a publication of standards or regulations. The views of the author expressed herein do not necessarily reflect the decision making process of NAPA with regard to advice or opinions on the merits of certain processes, procedures or equipment.

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Executive Summary

The popularity of paved bicycle paths and pedestrian trails has increased dramatically over the past decade. Many local agencies are looking for the best way to provide the most economical and safest trail surface. Hot Mix Asphalt (HMA) pavements have proven to give a smooth, flexible, long-lasting surface preferred by the outdoor enthusiast for recreational purposes and for use as a means of transportation and links to public transportation centers.

This report is intended to provide guidelines and recommendations for design and construction of asphalt pavements for trails and paths. Factors considered in selecting optional trail surfaces include costs, user preferences, durability, and aesthetics are presented. The report concludes with a summary of key factors contributing to quality HMA pavement paths and trails.

KEY WORDS:

Trails, Bike Paths, Hot Mix Asphalt, Construction

A Guideline for the Design and Construction of

Hot Mix Asphalt Pavements for Trails and Paths

ASPHALT TRAILS AND BIKE PATHS... THE RIGHT CHOICE

Roller-bladers, cyclists, and handicap users overwhelmingly prefer the continuous, joint-free travel that asphalt provides. This flexible pavement is softer, more forgiving, quieter, and provides the #1 characteristic that all users are looking for—smoothness.

The time of construction and repair for asphalt pavements is much less than for concrete, and asphalt pavements can be constructed with minimal impact on the existing terrain and environment. This is especially important for those locations where vegetation and tree growth impact during construction is kept to an absolute minimum.

A Guideline for the Design and Construction of

Hot Mix Asphalt Pavements for Trails and Paths

OVERVIEW

Throughout the country, more people are enjoying outdoor paths and trails for recreation than ever before. The success of Rails-to-Trails programs, which have converted unused railroad corridors to recreational trails used by joggers, cyclists, in-line skaters, and others who enjoy leisure outdoor activities, has spurred the popularity of paved trails. To meet the growing need for well-maintained recreational paths and trails, many state and local governments have begun to increase funding for such facilities. However, a good source for sound guidelines and specifications on the design and construction of paved trails has not been widely available.

This report provides guidelines and recommendations for design and construction of asphalt pavements for trails and paths. Factors considered in selecting optional trail surfaces include costs, user preferences, durability, and aesthetics are presented. The report concludes with a summary of key factors contributing to quality asphalt pavement paths and trails.

Properly designed asphalt pavements provide user-friendly, cost effective, long-lasting bike paths and trails with a surface which is smooth, quiet, and safe.

DESIGN CONSIDERATIONS

In order to properly design and construct functional trails, several factors must be considered. Pavements should be designed to fit the needs of the users and to accommodate local site conditions and materials. The existing terrain, climate, drainage, and pavement uses/loading need to be addressed in the design phase. The expected uses of the trail will affect the selection of trail surface as well as the width and grades of the path. Loads carried by the trail and the existing soil characteristics, in conjunction with drainage conditions, will affect the design thickness of the pavement and the design of the asphalt mixture.

Trail Surfaces / Pavement Types

The selection of surface material for trails and paths should be based on the anticipated type and intensity of trail use, terrain, climate, design life, maintenance, cost, and availability. Soft surface materials include earth, grass, wood chips, granular stone, and wood decking. Hard surface materials include cobblestone, brick, concrete, and asphalt. Hard surface materials are preferred for shared-use trails.

Each surface material type has advantages and disadvantages. Soft surface materials have low initial cost, but require substantial maintenance and are not suitable for many of the recreational activities that today's trails and paths are used for. Hard surface materials provide years of service with low maintenance. One specific advantage of asphalt pavements is that they can be constructed quickly and economically. Usually, the most significant factor when selecting the appropriate pavement type is the budget.

Cost

Comparisons of construction or life cycle costs for both asphalt and concrete trails always indicates tremendous savings with asphalt pavements. A 1998 construction cost study by Alpine Engineering of Edwards, Colorado showed that full-depth asphalt paved trails saved 35 to 50 percent compared to concrete trails. The guidelines presented in this report along with recommendations from your landscape architect and pavement design engineer should result in a trail that will perform well for 20 years with only minor maintenance.

User Preference

Asphalt pavements provide a continuous, smooth, joint-free, low maintenance surface. This flexible pavement alternative is quieter with superior smoothness preferred for cycling and rollerblading. Joggers and walkers also prefer the softer surface asphalt pavements provide.

Aesthetics

Paving techniques allow asphalt pavement to be placed on minor slopes, over undulating topography, and blended into the existing landscape. The free flow lines of asphalt pavement do not detract from the natural environment. In addition, asphalt pavement can be colored to preserve the natural setting. Subtle, natural-colored pavement may be accomplished using available polymer pigments, or by specifying colored aggregate which will provide a base color more visible through time.

Constructibility

Asphalt pavements can be constructed where space is limited and topography is rugged. Construction time is also significantly shorter for asphalt trails. For example, an 8.2-mile bicycle trail from Xenia to Cedarville, Ohio was paved in just eight working days to meet the deadline of a Labor Day celebration. This shorter construction time provides additional savings to the agency by reducing field inspection and management costs. In some climates, where the construction season is short, this reduced construction time can be a determining factor in the type of pavement selected.

Maintenance

Asphalt pavement maintenance will be minimized through proper design and construction. A significant advantage over concrete pavement is asphalt's ability to be repaired quickly and inexpensively. In areas where poor soil conditions exist, concrete slab movement caused by differential settlement can be costly to repair, requiring grinding of edges and/or expensive slab section replacement.

Asphalt pavement repairs can be made quickly and less costly and blended into the existing pavement structure. Mountain trails may be subject to springtime flooding and washout. These sections, when constructed with asphalt pavement, are not nearly as expensive to replace.

PAVEMENT DESIGN

PAVEMENT WIDTH

Design guidelines for bicycle path width, sight distance and other safety and user-friendly features are outlined in the *Guide for the Development of Bicycle Facilities*.[5] Trail design should also meet the Americans With Disabilities Act, including maximum slope and cross pitch requirements.

Design of the width of the pavement is primarily based on the intended uses of the path. Trails and paths must accommodate two-way traffic and a range of user travel speeds. The minimum recommended width for two-way shared-use paths is ten feet, with twelve feet recommended for heavy use areas. Shared-use trails must be wider to accommodate fast-moving bicyclists and skaters along with slower moving pedestrians and joggers. Sight distance and grade also affect the choice of pavement width for shared-use paths. Enough width should be provided to allow safe passing of slower moving users. If possible, trails and paths should be designed with a ten- to twelve-foot wide primary lane for bicyclists and skaters, and a separate five-foot wide soft surfaced trail for pedestrians and equestrians.

In order to design for cost-effective construction, the designer should also consider construction equipment size. Typical paving machine widths are ten feet, with eight-foot pavers available in some locations. Therefore, the minimum recommended width for any asphalt trail is eight feet. Most pavers are equipped with extendable screeds for paving wider areas as needed.

Paved trails should be constructed to match the existing topography as closely as possible, however, **longitudinal grades should not exceed five percent.**[5] Also, a pavement cross-slope of two percent is desirable to provide adequate drainage away from the pavement surface. Proper drainage is one of the most important factors affecting pavement performance. Surface water runoff should be handled using swales, ditches, and sheet flow. Catch basins, drain inlets, culverts, and underground piping may also be necessary. These features should be located safely away from the pavement structure.

PAVEMENT DESIGN AND THICKNESS

An experienced local pavement design engineer should be consulted to determine the design thickness for the trail pavement based on the anticipated uses, loading conditions, drainage, and soils information.

The first step to designing the pavement thickness is to determine the type and strength of the native soil and drainage conditions. A soils investigation should be performed to evaluate the subgrade, load support capabilities, surface water, and groundwater conditions. In some areas, the swell potential of the native soils must be addressed. The soil investigation should be performed with test locations at appropriate intervals to account for the varying soil conditions that may be encountered.

The most common tests performed on soils to characterize their load carrying capabilities are shown in Table 1. The R-Value test and the California Bearing Ratio (CBR) test provide relative soil strength values that have been used for many years in traditional roadway pavement design. For light duty pavements, such as trails, soil classification may be sufficient to provide a more simple indication of the adequacy of the soil for the trail pavement. Guidelines for assessing soil quality are given in Table 2.

Drainage of water is an important characteristic of the site. Soils that are often saturated due to a high water table or frequent surface runoff may have a dramatic loss of load carrying ability.

If soils with different strengths or classifications are encountered along the proposed trail, it is recommended that the more conservative rating of soil quality be used in the pavement analysis. This follows the common engineering practice of using the lower 10th percentile value of the soil strength test results as input in pavement design.

The use of a Dynamic Cone Penetrometer may be helpful in evaluating site uniformity and pretesting the soil prior to construction activities. One should keep in mind that the moisture content of the soil will impact the result of this test.

For areas with very poor soils, consideration should be given to improving the location with an appropriate

TABLE 1. Tests for Characterizing Strength of Soils for Trail Beds

	AASHTO Designation	*ASTM Designation*
Resistance R-Value	T 190 and T 99	D 2844
California Bearing Ratio (CBR)	T 193	D 1883 or D 4429
Soil Classification for Highways	M 145	D 3282
Unified Soil Classification System	—	D 2487

TABLE 2. General Ratings of Soil Quality for Trail Pavements

Relative Quality of Trail Bed Soil	R Value	CBR	Highway Soil Classification	Unified Soil Classification
High Quality	Greater than 80	Greater than 70	A-1	GW, SW, GP, GM
Good	55 to 80	20 to 70	A-2, A-3	SW, SP, SM, SC
Weak	25 to 55	5 to 20	A-4, A-5	ML, OL, MH
Very Poor	Less than 25	Less than 5	A-6, A-7	OH, CH, CL

treatment. This may include excavation and replacing with higher quality material, adding fill material over the native soil, stabilization with admixtures such as lime, fly-ash, or cement, or using reclaimed pavement materials as a base. Geotextiles can also be used to help stabilize the soil. The pavement design engineer or a geotechnical engineer can recommend an appropriate course of action.

The next step is to determine what kind of loading the pavement will carry. If periodic vehicular traffic, such as emergency, patrol, snow removal, maintenance, or other motor vehicles are expected to use the pavement, then the pavement must be designed to support these heavier loads. Table 3 provides a general guide for three levels of loading conditions.

The simple design guidelines provided in Table 4 can be used to determine an appropriate asphalt pavement thickness. If soil conditions along the trail vary, the designer may choose to alter the pavement cross-section to provide different design thicknesses in different areas of the trail. Local experience with asphalt paved trails may differ somewhat from these guidelines.

Full-depth asphalt pavement is the overwhelming choice for trails because of the speed of construction and long-term durability. However, depending on the existing soil's ability to support the construction loads, a base course of crushed stone or recycled pavement materials and/or a geotextile may help distribute the loads to the native soil. The use of a base course may also ease the grading of the trail for longitudinal profile and cross-slope. Composite pavement cross-sections, consisting of asphalt surface overlying a crushed stone or recycled pavement base course, may also be appropriate for stage construction.

For every two inches of the base course thickness, the asphalt layer can be reduced by one inch. However, the asphalt layer should never be less than 3 inches for heavy traffic conditions, or never less than 2 inches for light to medium traffic loads.

Aggregate base courses with a 3/4 to 1 1/2 inch nominal aggregate size material are recommended. Specifications for aggregate base courses should be referenced to AASHTO Designation M 147. For the purpose of grading, the aggregate base course layer should be placed at a thickness of at least three times the nominal maximum aggregate size.

TABLE 3. General Loading Conditions

General Loading Description	*Types and Frequency of Use*
Heavy	Heavily used trails for full range of activities from walking to biking, horseback riding, etc. Full-sized vehicles (e.g. pick-ups, tractors) are expected to periodically access the trail for maintenance, emergencies, and access to easements in the trail right-of-way.
Medium	Most often used for biking, roller-blading, scooters, etc. May carry light vehicles (e.g. golf carts) and infrequently heavier vehicles for maintenance.
Light	Mostly used for walking and jogging. Occasional bicycles, rollerblading, scooters, wheel-chairs, etc. No motorized vehicles.

TABLE 4. Guidelines for Thickness of Asphalt Paved Trails

Relative Quality of Trail Bed Soil	*Loading*	*Asphalt Pavement Thickness (inches)*
High Quality	Heavy Medium Light	3.5 to 4.0 3.0 to 3.5 2.5 to 3.0
Good	Heavy Medium Light	4.5 to 5.0 3.5 to 4.6 3.0 to 3.5
Weak	Heavy Medium Light	5.0 to 5.5 4.5 to 5.0 4.0 to 4.5
Poor Quality	Heavy Medium Light	6.0 to 6.5 5.5 to 6.0 5.0 to 5.5

Development of these recommendations assumes that the subgrade will be properly prepared. The subgrade should be stripped of vegetation, shaped to grade, and compacted at the proper moisture content prior to placement of the pavement structure. In general, compacting the subgrade to a minimum of 95 percent of the maximum density as determined by AASHTO

T 99, Standard Proctor, will provide adequate support. The moisture content of the subgrade should be controlled to within 3 percent of optimum moisture. The pavement design engineer should provide guidelines for proper compaction of the existing soil.

HOT MIX ASPHALT MIX DESIGN

Different types of Hot Mix Asphalt (HMA) are used for different pavement applications. The type of mix generally used for a highway is not appropriate for a trail or bike path.

The basic objectives for the design of an asphalt paving mixtures is to determine a cost-effective blend of aggregates and asphalt that yields a mix having: (1) sufficient asphalt to provide durability; (2) adequate stability to resist distortion and displacement; (3) a smooth, uniform surface texture; and (4) sufficient workability to allow proper field compaction to resist moisture damage. Proper proportioning of aggregate and asphalt provides a balance among these characteristics.

The composition of asphalt mixtures is largely dictated by local materials and performance experience. The most economical pavement will be one that utilizes locally available aggregates. It is strongly recommended to consult with local road department engineers and paving contractors to determine the best asphalt mixture(s) for the project.

Many successful paths and trails have been constructed with a relatively fine-graded aggregate blend having a nominal maximum size of 1/2 inch or less. The type of asphalt mixture appropriate for paved trails is similar to the type used for light duty parking lots. This type of mixture is easy to place and compact and will provide a tight, smooth surface. Since the trails are not subject to heavy loading, and large construction equipment may not have good access, the asphalt mix design should be a mixture with a reasonably high asphalt binder content and low air voids. This “rich” mix will provide excellent durability and allow for ease of placement and compaction. In addition, high asphalt content mixes minimize the potential for segregation and improve the surface texture of the mix for this type of application.

Several alternative mix design methods are utilized to design HMA in the United States. The most common HMA mix design methods include the Superpave method, the Marshall method and the Hveem method. The Superpave method was developed in the 1990s and has been primarily used for highway type mixtures. The Marshall and the Hveem method have been used for many years for designing a variety of asphalt paving mixtures. The Marshall method has been used throughout the central and eastern US; the Hveem method has been used primarily in the western states. Recommended criteria for a trail type HMA using these mix design methods are given in Table 5.

TABLE 5. Mix Design Methods and Criteria for Asphalt Trails[1]

DESIGN CRITERIA	*SUPERPAVE METHOD*	*MARSHALL METHOD*	*HVEEM METHOD*
COMPACTION	Design Gyrations = 50	50 Blows per Side	Kneading compactor
STABILITY	N/A	1200 lb. Minimum	minimum 30 Hveem
FLOW	N/A	0.08 – 0.18 inches	N/A
AIR VOIDS (%)	2 – 4	2 – 4	2 – 4
VOIDS IN MINERAL AGGREGATE (%)[2]	13 minimum for 1/2" nominal @ 3.0% Air Voids	13 minimum for 1/2" nominal @ 3.0% Air Voids	13 minimum for 1/2" nominal @ 3.0% Air Voids
TENSILE STRENGTH RATIO, %	75 minimum	75 minimum	75 minimum

1 The criteria provided in this table are recommended only as guidelines for development of the mix design; they are not intended to be used as quality control/quality assurance limits.
2 The minimum VMA should be adjusted for different nominal maximum aggregate size mixtures. Refer to the Asphalt Institute’s Manual Series-2 (2).

The selection of the asphalt binder grade should be based on the climatic conditions of the region. The pavement engineer should specify the appropriate grade for the project. A standard, unmodified, asphalt binder should be readily available and is appropriate for any trail loading condition.

Mix designs meeting the above criteria will provide an excellent, long-lasting pavement for cyclists, walkers, joggers, and rollerbladers. It is important to re-emphasize that using mix design criteria developed for vehicular traffic (e.g. roads and highways) will not provide, in most cases, a mix with sufficient durability and workability for paved trails. A mix developed for highway construction will generally contain less asphalt binder, higher voids, and be more prone to oxidation, raveling, and cracking on trails and bike paths. Designs developed for low-volume application, as outlined above, will compact easier, remain more flexible, and provide excellent service life.

GENERAL CONSTRUCTION GUIDELINES

Good construction practices will ensure a pavement that provides good serviceability throughout its design life. Recommendations provided by the pavement design engineer should be followed during construction. Proper drainage, subgrade compaction, adequate pavement thickness, and pavement compaction are the key elements to quality construction.

SUBGRADE

Prior to construction, vegetation should be cleared and stumps and roots removed along the trail to a minimum of five feet outside the edge of the proposed pavement. This will allow construction equipment access and help prevent future root and vegetation growth from encroaching on the path. If adequate access width cannot be provided, the contractor will be forced to use less efficient equipment with increased costs to the owner.

After removing vegetation and roots, the subgrade should be prepared by removing unstable soil, shaping to grade, scarifying the surface to a minimum depth of six inches, moisture conditioning, and compacting. The area of compacted subgrade should extend a minimum of two feet beyond the edge of pavement. The support of the subgrade can be easily evaluated by driving a loaded dump truck or heavy rubber tire roller over the trail after the compaction process. The dump truck (10-wheeled tandem axle truck) or roller should be loaded to at least 30,000 pounds and driven at a speed of 2 to 3 miles per hour over the surface to be paved. Areas that show a deflection of two inches or more should be recompacted, removed, and replaced with stable soil, or a base material added for improved support.

After compaction, a soil herbicide and/or root inhibitor should be applied. Application should be carefully controlled to the pavement area only. It is also important that all utility installations, including sprinkler systems, be complete prior to paving.

Typical shaping, grading, and compaction crews consist of a motor grader or blade, landscape tractor with back box for grading, and a rubber tire roller for compaction. Additional compaction equipment and access to water may be required.

If aggregate base course is used in the pavement section it should be compacted to a minimum of 95 percent of modified Proctor density, AASHTO Designation T 180, ASTM Designation D 1557. Depending on the soil conditions, compaction and moisture criteria may vary. Consult with the pavement design engineer for site specific information.

PLACEMENT

Placement of the Hot Mix Asphalt should be accomplished with a self-propelled paver, where possible. Where pavers cannot be used, a spreader box, attached to a dump truck may be used. Minimum paver width is generally eight feet. For widths less than eight feet, cut-off shoes may be placed in the screed to reduce the width of paving. Mat thickness and cross-slope are controlled by the screed. Vibratory screeds are common and provide initial compaction prior to rolling. In general, the uncompacted mat should be 1/4" per inch (25 percent) thicker than the final desired thickness to allow for densification during rolling operations.

The Hot Mix Asphalt should be delivered to the paver at a temperature adequate to allow proper compaction. The appropriate temperature range for compaction will depend upon the grade of asphalt binder used, but generally ranges between 235 and 300 ^{o}F. The contractor's ability to achieve compaction is dependent on the mix temperature, pavement thickness, subgrade support, subgrade temperature, ambient temperature, and wind velocity.

COMPACTION AND JOINT CONSTRUCTION

Compaction should be accomplished immediately after placement by the paver. Steel wheel vibratory rollers are generally used for initial (breakdown) rolling behind the paver, followed by a steel wheel finish roller. Depending on the compactibility of the mix, a pneumatic tired roller may also be used. Pneumatic tired rollers may have a tendency to pick up the asphalt and fines from the surface of the pavement. Proper tire temperature or the use of a release agent will minimize this problem. The contractor should provide rollers adequate to obtain the specified compaction. It is recommended the Hot Mix Asphalt be compacted to about 92 percent of the Theoretical Maximum Specific Gravity, AASHTO designation T 209, ASTM designation D 2041.

A transverse joint occurs at any point the paver ends work and then resumes at a subsequent time. Smoothness of such transverse joints is very important for some trail uses such as skating and roller-blading. The end of the paving mat should be cut off vertically with one of several common methods prior to resuming paving to allow the full lift thickness to be placed against it. A vertical edge can also be made with a papered transverse joint. The paver is stopped at the end of production and heavy wrapping paper is placed along the entire face of the vertical edge of the pavement. The paper extends approximately three to four feet onto the sub-grade. The paver resumes paving over the paper to form a taper. Prior to resumption of paving, the paper and mix on top of the paper is removed forming a vertical edge.

When paving resumes the vertical edge is tack-coated, and the paver backed over the existing asphalt with the screed resting on shims over the previously placed mat. The shims should have a height equal to 1/4 inch per inch of mat thickness (i.e. 1/2 inch shim for 2 inches of compacted mat). Mix is delivered to the paver and the paver starts forward slowly. Excess mix left by the paver is bumped back to the joint location and/or removed. If space allows, the joint is then rolled transversely from the cold side beginning with the roller approximately six inches on the newly placed mat and continuing across in six to 12 inch increments. Timbers should be placed along the outside edges of the mat to support the roller and minimize distortion of the outside edges.

After the paving and compaction operations are completed, the shoulders should be graded to match the edge of the pavement to prevent sharp drop-offs. The slope of the shoulder should be slightly greater than the cross-slope of the pavement. A variety of surfacings and types of shoulder material such as dirt, grass, wood chips, and fine-graded aggregate can be used depending on the uses of the trail. Some settlement of the shoulder material can be expected to occur in the first few months. A follow up treatment should be planned to return the shoulder to the correct grade.

Pavement markings such as centerline stripes, crossing warnings, etc. can be applied to the pavement a few days after the paving is completed. This short period of time allows the asphalt film on the pavement surface to cure so that the paint bonds well. However, if desired, the trail can be used and enjoyed by the public as soon as the construction is completed.

INSPECTOR'S ROLE

The inspector's role is important to the success of the pavement construction. It is the inspector's job to verify that the requirements of the plans and specifications are met in a safe manner. In this type of construction project, plans are often less detailed and may be ambiguous. The inspector must be able to exercise judgement and make decisions that ensure the construction of a quality pavement that will perform as planned.

INSPECTOR GUIDELINES

- Become familiar with the plans and specifications
- Develop a rapport with the contractor
- Schedule a preconstruction meeting as needed to clarify project details
- Verify lines, grades and drainage are correct
- Verify subgrade and/or base course has been tested
- Observe subgrade proof rolling
- Notify contractor of any deficiencies immediately
- Verify quality placement and compaction of asphalt pavement
- Verify the contractor's quality control of the HMA
- Ensure a safe work environment

Prior to beginning construction, the inspector should become familiar with all aspects of the plans, specifications, and construction schedule. A preconstruction meeting should be held several weeks prior to beginning work to review the plans and specifications, verify the contractor's schedule and receipt of submittals such as mix designs and product certifications, and discuss the overall construction techniques planned to be used to accomplish the project. This is an excellent opportunity for the contractor to ask questions and discuss potential problems and receive feedback from the contracting agency on how potential situations may be handled. Preconstruction meetings should be attended by the contracting agency, project engineer, construction inspector, contractor, significant subcontractors, and the pavement design engineer.

The rapport between the inspector and contractor is critical. The best pavement will be obtained by diplomatically working together to achieve the highest quality possible.

The inspector should oversee construction and be available to answer questions or know whom to contact to get answers to questions that may arise. The inspector's role is to verify that the plans and specifications are being adhered to, and make the contractor aware of any deficiencies immediately. The inspector must generally obtain approval from the project engineer for any changes to the design. The contractor's responsibility is to construct the project in accordance with the plans and specifications. The inspector may work with the surveyors, and testing laboratory, if necessary, to assist in interpreting the plans and specifications.

The inspector should verify the proper lines and grades, subgade compaction, mix temperature of the delivered Hot Mix Asphalt, quantity of material delivered, compaction of the asphalt pavement, thickness, smoothness, and proper joint construction.

The contractor should provide quality control for workmanship and materials. The inspector, through daily communication with the contractor, should verify that minimum test frequencies are being met, and should obtain copies of the test results in a timely manner. The inspector should verify that the mix delivered to the project is within the production tolerances of the mix design.

MAINTENANCE

A properly constructed asphalt pavement using an appropriate mix design will require minimal maintenance. Providing proper drainage is essential to reducing maintenance costs. Maintenance is generally divided into two categories, preventative maintenance and corrective maintenance. Preventive maintenance should be performed on a regular basis to remove vegetation, improve drainage, and resolve any unsafe conditions. Corrective maintenance is performed as needed to repair a specific pavement failure or distress area.

Regular maintenance should include sweeping the trail of debris, clearing of encroaching vegetation, correcting shoulder grades, and cleaning of ditches and drainage features. An annual inspection should be made to assess the overall condition of the asphalt pavement, pavement markings, and signage.

Sealing the surface of the asphalt pavement may help extend the life of an older asphalt pavement. Surface seals are used to retard oxidation of the asphalt, seal small cracks, provide additional moisture protection to the pavement, and retard raveling of aggregate from the surface. Common surface seals include fog seals, chip seals, and slurry seals. The type of seal used will depend on the age and condition of your pavement. In general, a fog seal will improve the moisture resistance of the pavement, reduce future oxidation, and fill small cracks. Chip seals and slurry seals will provide the benefits of fog seals and improve the surface texture of the pavement. Caution should be used on the application of chip seals to trails and paths. Chip seals generally result in a coarse surface that may not be desirable to rollerbladers and cyclists. Sealants and fog seals may also produce a very slick and unsuitable surface.

Cracks which are less than 1/4 inch wide are considered low severity, and rehabilitation alternatives can consist of 1) do nothing; 2) crack seal with an approved sealant; or 3) apply an emulsion material to primarily seal or protect the vertical crack sidewalls from further deterioration. Cracks 1/4 to 1/2 inch in width are considered medium severity. Rehabilitation alternatives may consist of application of a crack sealant, routing and filling with a sealant, or application of a surface treatment. Crack fill material should be left flush or

Trails placed along river-beds or other poor soil locations are susceptible to differential settling, heaving, and wash out. Asphalt is less expensive to repair or replace than concrete because grinding and slab replacement costs are avoided. If a proper preventive and corrective maintenance program is established, asphalt maintenance costs can minimized.

slightly below ($^1/_8$ to $^1/_4$ inch) the surface of the pavement. Cracks greater than $^1/_2$ inch are considered high severity and may entail a partial or full-depth patch or a surface treatment application. At some point, the frequency of cracks could be high enough to warrant a more complete rehabilitation such as mill and overlay, replacement of the HMA, or reconstruction. Local construction culture, economics, and material availability will influence decisions for maintenance options.

SUMMARY

This guide has been prepared to aid in the proper design and construction of asphalt pavement for paths and trails. Properly designed and constructed asphalt pavements, together with the proper thickness and proper preparation, will help ensure a high quality product. Specifying asphalt pavement trails and paths provides the agency and public with numerous benefits.

BENEFITS OF ASPHALT PAVEMENT TRAILS

- Cost effective construction providing users with more miles of usable paths.
- A user-friendly surface providing a safe, smooth, quiet, continuous surface with no joints for more enjoyable cycling or rollerblading.
- Flexible asphalt surfaces that are more forgiving for walkers and joggers.
- An aesthetically pleasing pavement surface that is constructed to blend with existing contours.
- A low maintenance surface providing ease of repair.
- Fast construction time allowing more efficient use of personnel and increased trail use by the public.

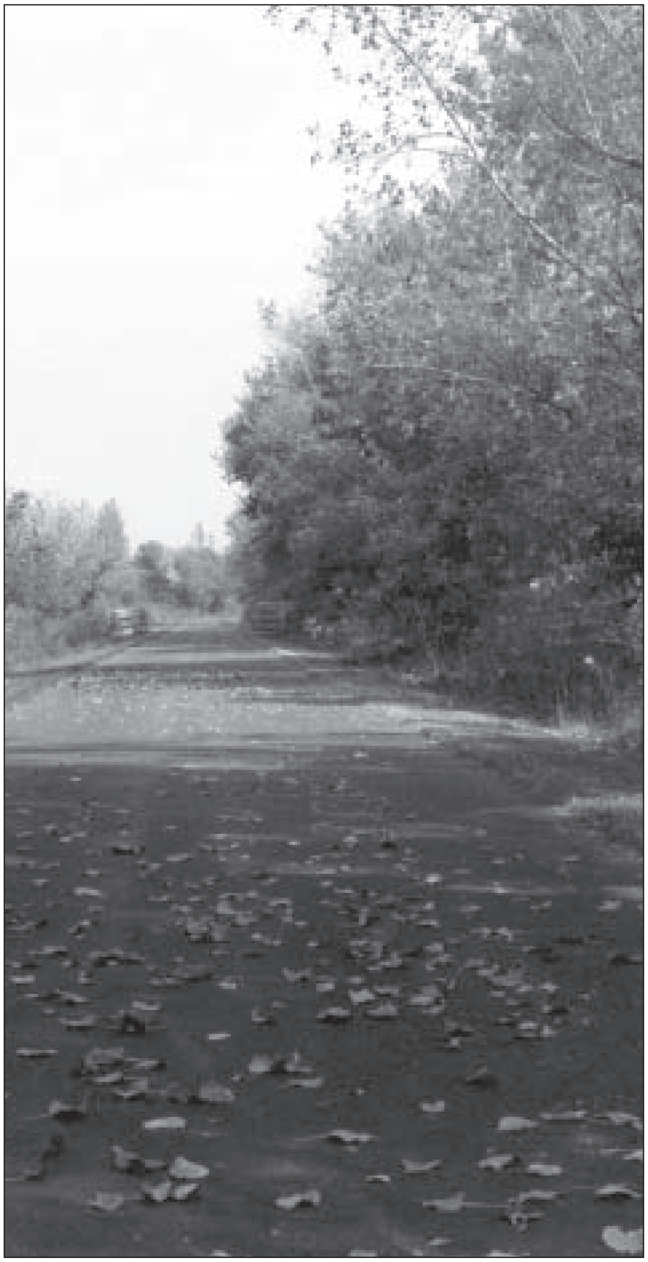
It is the responsibility of the trail design team, comprised of the owner, landscape architect, civil engineer, pavement engineer, and other professionals, along with the contractor, to ensure the benefits of asphalt pavement are realized. Outlined below are the keys to successful construction and a long-lasting, high quality trail.

KEYS TO QUALITY ASPHALT TRAILS

- Design the pavement to meet the needs of the anticipated users.
- Follow guidelines in *AASHTO Guide for the Development of Bicycle Facilities, 1999*, for path width, sight distances, clearance, grade, signage, etc.
- Determine the strength characteristics of the native soils.
- Determine the expected pavement loading conditions.
- Design the pavement section to meet soil, loading, and environmental conditions.
- Provide good drainage.
- Design the asphalt mixture to meet the expected loading conditions.
- Properly compact the asphalt pavement.
- Plan preventative maintenance.

Bibliography

1. *Principles of Construction of Hot Mix Asphalt Pavements*. Manual Series No. 22 (MS-22), Asphalt Institute, Lexington, Kentucky: 2nd edition, 1998.
2. *Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types*. Manual Series No. 2 (MS-2), Sixth Edition, Asphalt Institute, Lexington, Kentucky.
3. *The Superpave Mix Design Manual for New Construction and Overlays*. SHRP-A-407, Strategic Highway Research Program, National Research Council, Washington, D.C.: May 1994.
4. *Asphalt Pavement for Athletics and Recreation*. Asphalt Institute, Kentucky and National Asphalt Pavement Association, Maryland: August 1985.
5. *Guideline for the Development of Bicycle Facilities*. American Association of State Highway and Transportation Officials, Washington, D.C.: 1999.
6. Technical Brief. National Bicycle and Pedestrian Clearinghouse: August 1996.
7. *Bicycle Compatible Roadways and Bikeways*. New Jersey Department of Transportation.
8. Roberts, F. L., Kandhal, P. S., Brown, E. R., Lee, D. Y., Kennedy, T. W., *Hot Mix Asphalt Materials, Mixture Design and Construction*. NAPA Research and Education Foundation, Lanham, Maryland: 1991.
9. Duffy, H., *Surface Materials for Multi-Use Pathways*. National Park Service, Rocky Mountain Region: April 1992.
10. Flink, C. A., Lagerwey, P., Balmori, D., Seams, R. M., *Trails for the Twenty-First Century, Planning, Design, and Management Manual for Multi-Use Trails*. Washington, D.C.
11. *Trail Construction Guidelines*. Colorado State Recreational Trails Program, Denver: 1981.
12. Flink, C. A., Seams, R. M., Greenways, *A Guide to Planning, Design, and Development*. The Conservation Fund, Washington, D.C.
13. Parker, T. S., *Trails Design and Management Handbook*. Open Space and Trails Program, Pitkin County, Colorado: January, 1994.



Asphalt pavement construction techniques allow it to be placed on minor slopes and blended into the existing topography. In addition, many agencies are preserving the natural setting of trails by customizing their color through the use of polymer pigment or with colored aggregates. This color enhancement allows an asphalt trail to blend in more naturally with its environment.

An analysis of the construction costs of different pavement types indicates a significant initial cost savings can be realized by using asphalt pavement. Also, if properly designed and constructed, the life cycle costs of asphalt pavement trails have been found to be equal or better than concrete. Asphalt pavement is most often the pavement of choice and recommended by designers for those organizations or agencies with limited budgets.

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