HOT-MIX ASPHALT PAVEMENT DESIGN GUIDE

PENNSYLVANIA ASPHALT PAVEMENT ASSOCIATION

PAPA

Requirements For Long-Term Hot-Mix Asphalt Pavement Performance

1. **GOOD PLANNING**

2. **GOOD DESIGN**

3. **GOOD CONSTRUCTION**

   Materials
   Subgrade
   Workmanship

4. **GOOD MAINTENANCE**

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PAPA


ONLY
ONLY
ONLY
SPEED
LIMIT
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RIGHT LANE
MUST
TURN RIGHT

FORWARD

This *Pavement Design Guide*, prepared by the Pennsylvania Asphalt Pavement Association (PAPA), is provided for the practitioner (architect, municipal and township engineer, and developer) who to some extent is involved with the design of hot-mix asphalt (HMA) pavements of various types constructed in Pennsylvania. The guide uses generalizations and simplifications from standard specifications for the user to design economic and satisfactory pavements that will provide good performance with relatively little maintenance in future years of service.

PAPA is indebted to Mr. Carlos Rosenberger, P.E., Senior District Engineer, Asphalt Institute, Lexington, Kentucky, for his technical input and assistance in the preparation of this guide. Mr. Rosenberger's years of HMA knowledge and practical experience provided PAPA with an immeasurable resource person.

INTRODUCTION

This guide is provided by the Pennsylvania Asphalt Pavement Association (PAPA) as a tool for owners, architects, engineers and developers when preparing plans and specifications for pavements to be constructed in Pennsylvania.

The guide is not intended to be used as a substitute for professional asphalt pavement design by competent engineers using specific traffic and soils information. By necessity this manual uses generalizations and simplifications; however, the use of these designs and specifications, together with proper construction controls, will provide users with economic and satisfactory pavements that will provide good performance with relatively little maintenance.

This guide has been prepared in order to bring designers information on the current Pennsylvania Department of Transportation (PENNDOT) Specifications and to incorporate the latest knowledge, techniques and technology that have been developed in asphalt pavement construction over the past several years. This publication is not intended to set standards or regulations. The views of the authors expressed herein do not necessarily reflect the decision making process with regards to the advice, opinions or merits of certain processes, procedures or equipment.

HOT-MIX ASPHALT (HMA)

WHAT IS HMA?

Hot-mix asphalt (HMA) may be referred to by several names. In different sections of the state it may also be referred to as bituminous concrete, hot plant mix, asphalt concrete, blacktop or SUPERPAVE.

HMA is composed of aggregate bound together into a solid mass by asphalt cement. The aggregates total ninety-three (93) to ninety-seven (97) percent by weight of the total mixture and are mixed with three (3) to seven (7) percent asphalt cement. It is manufactured in a central mixing plant where the asphalt and aggregates are heated to a temperature of approximately 300ºF, properly proportioned and mixed. The completed paving mixture is hauled by trucks to the mechanical spreader where it is placed in a smooth layer and compacted by rollers while still hot. HMA may be placed by hand when it is impractical to use a paver. Successful HMA pavement construction requires good planning, design, construction (materials, subgrade, workmanship) and planned future maintenance.

Asphalt pavements are constructed of one or more courses of HMA placed directly on the subgrade or on an aggregate base.

HMA SPECIFICATIONS

All work involving HMA pavements and resurfacing can be specified by using the PENNDOT Specifications Publication 408/2003 in conjunction with the typical sections that follow.

HMA RESURFACING

Resurfacing is the placing of one or more courses of HMA over an existing asphalt or concrete pavement. This is the means for extending the service life of pavements.

ADVANTAGES OF HMA

1. Versatility
    - HMA pavements can be designed to handle virtually any traffic loading, soils and materials, and can be used to salvage old pavements as well as to build new ones.
    - Phased construction can easily be incorporated.

2. Economy
   HMA pavements:
    - are economical to construct
    - can be constructed rapidly and are immediately ready for use
    - can be recycled
    - require minimal maintenance
    - provide outstanding performance

3. HMA pavements are not affected by ice control chemicals.

4. Building and site esthetics are enhanced.

5. Traffic noise is minimized when HMA pavement is used.

6. Pavement striping is highly visible on the black HMA surface.

SPECIFICATIONS FOR HMA

Superior Performing Asphalt Pavement (SUPERPAVE) is a state-of-the-art paving system which Pennsylvania's industry has embraced. Marshall mixes, while still available, should be replaced with the appropriate SUPERPAVE specifications contained in PENNDOT's Bulletin 27 (Publication 27) for design of HMA mixes.

There are a wide variety of HMA mixtures used in Pennsylvania that vary from fine to coarse in size and gradation. Furthermore, Pennsylvania HMA mixtures utilize different aggregates or combinations of aggregates; the principal types being crushed stone, sand, and gravel. Good economics dictate the use of local aggregates meeting PENNDOT's quality requirements.

The most widely used HMA specifications in Pennsylvania are those contained in PENNDOT Specifications Publication 408/2003. PAPA recommends the use of these specifications. A copy of the PENNDOT Specifications Publication 408/2003 can be obtained from the Pennsylvania Department of Transportation Sales Store, P.O. Box 2028, Harrisburg, PA 17105 (www.dot.state.pa.us).

BASE DESIGNATIONS (Refer to Chart 1)

25 mm SUPERPAVE
minimum lift thickness of 4" is recommended.

19 mm SUPERPAVE
A minimum lift thickness of 3" is recommended.

12.5 mm SUPERPAVE
A minimum lift thickness of 2" is recommended.

9.5 mm SUPERPAVE
A minimum lift thickness of 1.5" is recommended.

Note: Aggregate sizes of the mix design should be checked prior to use in thinner lifts.

SURFACE DESIGNATIONS (Refer to Chart 1)

12.5 mm SUPERPAVE
This surface mix has a high stability designed for use on roadways with:
Average Daily Traffic (ADT) greater than 15,000
Recommended minimum lift thickness 2"

9.5 mm SUPERPAVE
This surface mix is recommended for most surface applications.
Recommended minimum lift thickness 1.5"

Stone Matrix Asphalt (SMA)
This is a high stability mix designed for specific conditions such as principal arterials and high volume Interstate Highways.

ID-2, ID-3, BCBC
These surface mixes designed by the Marshall procedure were previously specified by PENNDOT and are sometimes still produced; however, PAPA no longer recommends the use of these materials. The *following table provides a bridge for relating Marshall to SUPERPAVE mixtures:

Relationship Between Marshall Mixtures and SUPERPAVE Mixtures

SUPERPAVE	MARSHALL
9.5 mm	ID-2W
12.5 mm	—
19 mm	ID-3
25 mm	ID-2B, BCBC
SMA	—

CHART 1: RECOMMENDED MIXES FOR NORMAL HMA APPLICATIONS						
TRAFFIC CLASS 1 AND 2						
	Aggregate Size	**Binder Type**	**Compaction Level**	**Minimum Lift Thickness**	**Recomended Lift Thickness**	**Maximum Lift Thickness**
Surface	9.5 mm	PG 64-22	50 gyrations	1"	1.5"	1.5"
Base	19 mm	PG 64-22	50 gyrations	2"	3"	3"
	25 mm	PG 64-22	50 gyrations	3"	4"	5"
TRAFFIC CLASS 3						
	Aggregate Size	**Binder Type**	**Compaction Level**	**Minimum Lift Thickness**	**Recomended Lift Thickness**	**Maximum Lift Thickness**
Surface	9.5 mm	PG 64-22	75 gyrations	1"	1.5"	1.5"
Base	19 mm	PG 64-22	75 gyrations	2"	3"	3"
	25 mm	PG 64-22	75 gyrations	3"	4"	5"
TRAFFIC CLASS 4						
	Aggregate Size	**Binder Type**	**Compaction Level**	**Minimum Lift Thickness**	**Recomended Lift Thickness**	**Maximum Lift Thickness**
Surface	9.5 mm	PG 64-22	100 gyrations	1"	1.5"	1.5"
	9.5 mm	PG 76-22	100 gyrations	1"	1.5"	1.5"
	9.5 mm SMA	PG 76-22	100 gyrations	1"	1.5"	1.5"
	12.5 mm SMA	PG 76-22	100 gyrations	1.5"	2"	2"
Base	19 mm	PG 64-22	75 gyrations	2"	3"	3"
	25 mm	PG 64-22	75 gyrations	3"	4"	5"

ASPHALT PAVING MIXTURES

The pavement design requires the proper HMA paving mixtures for the base and surface pavements.

It is important that a Job Mix Formula (JMF) for the paving mixture be established. A producer, providing standard mixes, can readily furnish the engineer with a written JMF.

The asphalt mixtures referred to in this manual are PENNDOT Job Mix Designs which are readily available throughout Pennsylvania and have proven through extensive use to have all of the desirable characteristics of good asphalt pavements. PENNDOT's Bulletin 27 (Publication 27) provides the specifications for HMA mix design and procedures.

PERFORMANCE GRADE (PG) ASPHALT

The SUPERPAVE liquid asphalt specification is based on performance rather than on empirical relationships between basic physical properties and observed performance. Performance Graded (PG) asphalts are selected based on the climate and traffic in which the pavement will serve. Unlike all other systems, the physical property requirements are constant among all performance grades. The distinction among the various asphalt grades is the specified minimum and maximum temperatures at which the requirements must be met. For example, an asphalt classified as a PG 64-22 means that the asphalt will meet the high temperature physical property requirements of the pavement up to a temperature of 64ºC (147.F) and the low temperature physical property requirements of the pavement down to -22ºC (-8ºF). PG 64-22 is the liquid asphalt (asphalt cement) that should be specified in most applications.

Information on the Performance Grade (PG) asphalts may be found in PENNDOT's Bulletin 25 (Publication 37), "Specifications for Bituminous Materials." Information on plant requirements and mix designs may be found in PENNDOT's Bulletin 27 (Publication 27), "Bituminous Concrete Mixtures, Design Procedures, and Specifications for Special Bituminous Mixtures."

SUPERPAVE GYRATORY COMPACTION

The SUPERPAVE gyratory compactor is a laboratory compaction device that orients the aggregate particles in a way similar to that observed on the project when compacted by the roller. In order words, mixtures are compacted to provide a laboratory density equivalent to density in the field after various traffic levels. Laboratory specimens are compacted in the gyratory compactor based on specified number of gyrations related to design traffic levels and design high air temperatures. The mix design method uses volumetrics (air voids, voids filled with asphalt and voids in the mineral aggregate) to select the optimum asphalt content.

TACK COAT

A tack coat of asphalt (usually emulsified asphalt) is applied to ensure bond between the existing surface and the asphalt overlay. It should be applied in an even, thin coat at a rate of application between 0.02 gal/yd^2 and 0.07 gal/yd^2 for asphalt residue. Excessive tack coat can cause slippage or can flush to the surface. All longitudinal and transverse joints shall be properly tacked if they are below 140°F.

SUBGRADE SPECIFICATIONS

Topsoil, large rocks, and other types of low quality, unsuitable soil shall be removed and replaced. The subgrade must be properly shaped to the desired sections and elevation and shall be compacted so that it is firm, hard, and unyielding. A firm and unyielding subgrade is essential for good pavement construction. It shall be compacted to 100% of dry weight density as determined by Pennsylvania Test Method (PTM) 106, Method B. In-place density or compaction shall be determined in accordance with PTM 112 or PTM 402. To prevent growth of weeds, the subgrade should be treated with an approved herbicide. (See NAPA Publication IS-51)

RELATED HMA SPECIFICATIONS

The PENNDOT Specifications Publication 408/2003 contains the following sections for HMA pavements:

Section	
305	Subbase
309	SUPERPAVE Asphalt Mixture Design, Standard Construction, HMA Base Course
401	Conventional Mixture Design, Standard and RPS Construction of Plant-Mixed HMA Courses
409	SUPERPAVE Mixture Design, Standard and RPS Construction of Plant-Mixed HMA Courses
491	Milling of Bituminous Pavement Surface
703	Aggregate

ESTIMATING QUANTITIES

For a cursory estimate of the quantity of material required, use—110-120 lbs/sq/in.

ENGINEERING SERVICES

PAPA welcomes the opportunity to work with architects, consulting engineers, public agency officials, owners, and industry engineers in the preparation of pavement specifications, construction details, and construction controls toward the end of quality asphalt pavement installations. The Association's address and telephone number appear on the back cover. Other sources where information and guidance on asphalt pavement construction may be obtained are:

National Asphalt Pavement Association
5100 Forbes Boulevard
Lanham, Maryland 20706-4407
T: 301-731-4748 or 888-468-6499
F: 301-731-4621
E-mail: napa@hotmix.org

Asphalt Institute
Carlos Rosenberger
P. O. Box 337 (2-E Harrisburg Street)
Dillsburg, PA 17019
T & F: 717-432-5965
E-mail: carlosrosenberger@asphaltinstitute.org

Asphalt Institute
Research Park Drive
P.0. Box 14052
Lexington, Kentucky 40512-4052
T: 859-288-4960
F: 859-288-4999

A modern HMA facility provides high production, good quality mixes (including recycled asphalt pavement if desired) while meeting stringent air quality standards.

CHART 2: TRAFFIC CLASSIFICATION		
Type of Facility and Vehicle Types	**Maximum Trucks per Month (One Lane)**	**Traffic Class**
Residential driveways, parking stalls, parking lots for autos and pickup trucks. No regular truck traffic.	0	Class 1
Residential streets without regular truck traffic or city buses; traffic consisting of autos, home delivery trucks, trash pickup, occasional moving vans, etc.	60	Class 2
Collector streets, shopping center delivery lanes; up to 10 single-unit or 3-axle semi-trailer trucks per day or equivalents; average gross weights should be less than legal limit.	300	Class 3
Heavy trucks; up to 75 fully loaded 5-axle semi-trailer trucks per day; equivalent trucks in this class may include loaded 3-axle and 4-axle dump trucks, gross weights over 40,000 lbs.	2,250	Class 4

PAVEMENT DESIGN

The design of a HMA pavement requires some knowledge of the following:

Traffic
Drainage
Subgrade Soils Support

TRAFFIC

Asphalt pavements must be designed using the proper number and weight of axle loads expected during a given period of time to ensure adequate pavement performance. Of primary concern is heavy truck and bus traffic. Pavement life can be significantly affected by truck/bus traffic due to load-associated distresses; therefore, the weight and volume of the heaviest traffic is a principal factor in pavement design. Refer to Chart 2 for traffic classification.

DRAINAGE

Proper drainage is imperative in the design and construction of HMA pavements. Where high water tables occur or where water may accumulate in low areas, consideration must be given to subsurface drainage. The installation of underdrains and/or interceptor drains may be required to prevent the accumulation of water beneath the pavement structure.

Good surface drainage is also essential. A minimum slope or crown of 2% per foot is recommended. The roadway shoulder or adjacent ground should be graded so that surface drainage runs away from the pavement and does not stand on the pavement's edge.

Sloped sections, catch basins, and storm drains may be necessary for proper drainage on large parking lots.

AGGREGATE BASE

In certain situations graded aggregate base construction may be desirable. Aggregate base is placed between the HMA courses of the pavement and the compacted subgrade. For best performance, the aggregate base should be well-graded, consist of predominantly angular particles, have a maximum particle size of approximately 3/4", and be compacted to 100% of the maximum dry-weight density in accordance with PENNDOT's PTM No. 106, Method B. Further details are provided in PENNDOT's Specifications Publication 408/2003 (Section 350 and 703).

SUBGRADE SOILS

The Asphalt Institute's *Soils Manual for Design of Asphalt Pavement Structures,* Manual Series No. 10 (MS-10), describes in detail the commonly used soil evaluation systems and test procedures listed below. Field evaluation of the soil involves visual inspection and simple field tests.

- **Resilient Modulus (M_R)**

  A test used for evaluating the stress-strain properties of materials for pavement thickness design. This test measures the stiffness of the material.

- **California Bearing Ratio (CBR)**

  A test used for evaluating bases, subbases, and subgrades for pavement thickness design. This test is a comparative measure of the shearing resistance and provides the load-bearing value of the material.

- **Resistance Value (R-value)**

  A test used for evaluating bases, subbases, and subgrades for pavement thickness design. This test measures the frictional resistance of the material.

Poor Subgrade Soils

These soils become quite soft and plastic when wet. Included are those soils having appreciable amounts of clay and fine silt. The coarser silts and sandy loams also may exhibit poor bearing properties in areas where frost penetration into the subgrade is a factor. Typical properties: Resilient modulus = 30 MPa (4,500 psi), CBR = 3, R-value = 6.

Medium Subgrade Soils

These retain a moderate degree of firmness under adverse moisture conditions. Included are such soils as loams, silty sands, and sand-gravels containing moderate amounts of clay and fine silt. Typical properties: Resilient modulus = 80 MPa (12,000 psi), CBR = 8, R-value = 20.

Good to Excellent Subgrade Soils
Good subgrade soils retain a substantial amount of their load-support capacity when wet. Included are the clean sands and sand-gravels and soils free of detrimental amounts of plastic materials. *Excellent* subgrade soils are unaffected by moisture or frost. They include clean and sharp sands and gravels, particularly those that are well graded. Typical properties: Resilient modulus = 170 MPa (25,000 psi), CBR = 17, R-value = 43.

HMA RECYCLING

HMA recycling is a proven technology. It is cost effective, meets all specifications, and the quality of the recycled asphalt pavement has been proven to be equal to conventional mixes. When using recycled asphalt pavement (RAP) in HMA, the virgin aggregate and asphalt are reduced. In addition, the use of RAP and reclaimed asphalt materials aids the environment. Recycling may include the use of glass, plastic, asphalt, asphalt shingles, crumb rubber, and paper. Appendix H of PENNDOT's Bulletin 27 (Publication 27) provides SUPERPAVE design guidelines for using hot-mix recycled asphalt pavement.

Removal of badly deteriorated pavements, surface irregularities and maintaining curb reveal, etc. can be economically accomplished with minimal disruption to traffic using the cold milling or carbide grinding process. The RAP obtained through these processes can be recycled in a cost-effective rehabilitation process. (PENNDOT Specifications Publication 408/2003, Section 491—Milling of Bituminous Pavement Surface)

SIDEWALKS, GOLF CART PATHS, BIKE PATHS

SUBGRADE

Subgrade soils must be evaluated to determine the load-supporting characteristics. Refer to page 9. The subgrade must be properly shaped to the desired section and elevation and shall be compacted. Refer to page 5.

DRAINAGE

Good subsurface and surface drainage is essential to quality hot-mix asphalt pavements. Refer to pages 8-9.

AGGREGATE BASE CONSTRUCTION

In certain situations, graded aggregate base construction may be desirable. Good subsurface and surface drainage is essential to quality HMA pavements. Refer to page 9.

HMA CONSTRUCTION

A single course of 9.5 mm mixture is recommended due to the confined areas generally involved where constructing sidewalk, golf cart paths or bike paths except where poor subgrade is encountered. The 9.5 mm, 12.5 mm and 25 mm courses should be placed by a paver. Handwork should be restricted where feasible. HMA shall be designed, mixed, and constructed in accordance with PENNDOT Specifications Publication 408/2003.

CONSTRUCTION DETAILS 1 (TRAFFIC CLASS 1)				
Subgrade Class	**Constructed Layer**	**Compacted Thickness**	**Design Level**	**SUPERPAVE Mix**
Good	Surface	1"	50 gyrations	9.5 mm
	Base	2"	50 gyrations	19 mm
Medium	Surface	1.5"	50 gyrations	9.5 mm
	Base	2"	50 gyrations	19 mm
Poor	Surface	1.5"	50 gyrations	9.5 mm
	Base	3"	50 gyrations	25 mm

SIDEWALKS, GOLF CART PATHS, BIKE PATHS

CONSTRUCTION DETAILS 1A (TRAFFIC CLASS 1)				
Subgrade Class	**Constructed Layer**	**Compacted Thickness**	**Design Level**	**SUPERPAVE Mix**
Good	Surface	1"	50 gyrations	9.5 mm
	Base	2"	50 gyrations	19 mm
Medium	Surface	1.5"	50 gyrations	9.5 mm
	Base	2"	50 gyrations	19 mm
Poor	Surface	1.5"	50 gyrations	9.5 mm
	Base	2"	50 gyrations	19 mm
	Aggregate Base	4"		

RESIDENTIAL DRIVES, PLAY AREAS

PAVEMENT WIDTH

The pavement should be a minimum 10’ width on residential driveways for a single automobile. The minimum radius for a right angle where the driveway meets the street is 10’.

SUBGRADE

Subgrade soils must be evaluated to determine the load-supporting characteristics. Refer to page 9. Top soil must be removed and subgrade properly shaped to the desired section and elevation and shall be compacted. (Refer to page 5) Treat the subgrade with an approved herbicide to inhibit future weed growth.

AGGREGATE BASE CONSTRUCTION

In certain situations graded aggregate base construction may be desirable. Good subsurface and surface drainage is essential to quality hot-mix asphalt pavements. Refer to page 9.

TACK COAT

Refer to page 5.

HMA CONSTRUCTION

HMA shall be designed, mixed and constructed in accordance with PENNDOT Specifications Publication 408/2003.

The HMA base may be placed in a single course to the required thickness. Small mechanical pavers are available for this type of construction. The 9.5 mm, 12.5 mm and 25 mm courses should be placed by a paver. However, where access to the work area is limited, hand placement may be the only feasible method.

CONSTRUCTION DETAILS 1 (TRAFFIC CLASS 1)				
Subgrade Class	**Constructed Layer**	**Compacted Thickness**	**Design Level**	**SUPERPAVE Mix**
Good	Surface	1"	50 gyrations	9.5 mm
	Base	2"	50 gyrations	19 mm
Medium	Surface	1.5"	50 gyrations	9.5 mm
	Base	2"	50 gyrations	19 mm
Poor	Surface	1.5"	50 gyrations	9.5 mm
	Base	3"	50 gyrations	25 mm

RESIDENTIAL DRIVES, PLAY AREAS

CONSTRUCTION DETAILS 1A (TRAFFIC CLASS 1)				
Subgrade Class	**Constructed Layer**	**Compacted Thickness**	**Design Level**	**SUPERPAVE Mix**
Good	Surface	1"	50 gyrations	9.5 mm
	Base	2"	50 gyrations	19 mm
Medium	Surface	1.5"	50 gyrations	9.5 mm
	Base	2"	50 gyrations	19 mm
Poor	Surface	1.5"	50 gyrations	9.5 mm
	Base	2"	50 gyrations	19 mm
	Aggregate Base	4"		

SUGGESTIONS FOR OBTAINING A QUALITY RESIDENTIAL DRIVEWAY PAVEMENT

Select contractors known for quality work and established reputations in the community. Ask for local references.

Insist on a written contract or agreement. An example is provided in the Appendix. Specify materials and workmanship in accordance with PENNDOT Specifications. Specify a minimum compacted thickness.

PARKING LOTS, RESIDENTIAL OR LIGHT DUTY STREETS, STORAGE AREAS

SUBGRADE

Subgrade soils must be evaluated to determine the load-supporting characteristics. Refer to page 9.

The subgrade must be properly shaped to the desired section and elevation and shall be compacted. Refer to page 5.

DRAINAGE

Good subsurface and surface drainage is essential to quality hot-mix asphalt pavements. Refer to pages 8-9.

TACK COAT

Refer to page 5.

AGGREGATE BASE CONSTRUCTION

In certain situations graded aggregate base construction may be desirable. Good subsurface and surface drainage is essential to quality HMA pavements. Refer to page 9.

HMA CONSTRUCTION

HMA shall be designed, mixed and constructed in accordance with PENNDOT Specifications Publication 408/2003.

If several courses are desired or if job specifications require several courses, it is recommended that the first base course be 3” minimum depth.

An intermediate course of 9.5 mm should be added to reduce permeability and increase durability during construction if the final surface is not scheduled until subdivision build out.

PARKING LOTS, RESIDENTIAL OR LIGHT DUTY STREETS, STORAGE AREAS

CONSTRUCTION DETAILS 2 (TRAFFIC CLASS 2)				
Subgrade Class	**Constructed Layer**	**Compacted Thickness**	**Design Level**	**SUPERPAVE Mix**
Good	Surface	1.5"	50 gyrations	9.5 mm
	Base	2.5"	50 gyrations	19 mm
Medium	Surface	1.5"	50 gyrations	9.5 mm
	Base	3"	50 gyrations	19 mm
Poor	Surface	1.5"	50 gyrations	9.5 mm
	Base	4.5"	50 gyrations	25 mm

CONSTRUCTION DETAILS 2A (TRAFFIC CLASS 2)				
Subgrade Class	**Constructed Layer**	**Compacted Thickness**	**Design Level**	**SUPERPAVE Mix**
Good	Surface	1.5"	50 gyrations	9.5 mm
	Base	2.5"	50 gyrations	19 mm
Medium	Surface	1.5"	50 gyrations	9.5 mm
	Base	3"	50 gyrations	19 mm
Poor	Surface	1.5"	50 gyrations	9.5 mm
	Base	3"	50 gyrations	19 mm
	Aggregate Base	6"		

MINOR ARTERIAL AND LIGHT INDUSTRIAL STREETS

SUBGRADE

Subgrade soils must be evaluated to determine the load-supporting characteristics. Refer to page 9.

The subgrade must be properly shaped to the desired section and elevation and shall be compacted. Refer to page 5.

DRAINAGE

Good subsurface and surface drainage is essential to quality hot-mix asphalt pavements. Refer to pages 8-9.

TACK COAT

Refer to page 5.

AGGREGATE BASE CONSTRUCTION

In certain situations graded aggregate base construction may be desirable. Good subsurface and surface drainage is essential to quality hot-mix asphalt pavements. Refer to page 9.

HMA CONSTRUCTION

HMA shall be designed, mixed and constructed in accordance with PENNDOT Specifications Publication 408/2003.

If several courses are desired or if job specifications require several courses, it is recommended that the first base course be 3” minimum depth.

CONSTRUCTION DETAILS 3 (TRAFFIC CLASS 3)				
Subgrade Class	**Constructed Layer**	**Compacted Thickness**	**Design Level**	**SUPERPAVE Mix**
Good	Surface	1.5"	75 gyrations	9.5 mm
	Base	3"	75 gyrations	19 mm
Medium	Surface	1.5"	75 gyrations	9.5 mm
	Base	4.5"	75 gyrations	25 mm
Poor	Surface	1.5"	75 gyrations	9.5 mm
	Base	3"	75 gyrations	19 mm
	Base	3.5"	75 gyrations	25 mm

MINOR ARTERIAL AND LIGHT INDUSTRIAL STREETS

CONSTRUCTION DETAILS 3A (TRAFFIC CLASS 3)				
Subgrade Class	**Constructed Layer**	**Compacted Thickness**	**Design Level**	**SUPERPAVE Mix**
Good	Surface	1.5"	75 gyrations	9.5 mm
	Base	3"	75 gyrations	19 mm
Medium	Surface	1.5"	75 gyrations	9.5 mm
	Base	4.5"	75 gyrations	25 mm
Poor	Surface	1.5"	75 gyrations	9.5 mm
	Base	5"	75 gyrations	25 mm
	Aggregate Base	6"		

PRINCIPAL ARTERIAL, COMMERCIAL OR INDUSTRIAL ROADS

SUBGRADE

Subgrade soils must be evaluated to determine the load-supporting characteristics. Refer to page 9.

The subgrade must be properly shaped to the desired section and elevation and shall be compacted. Refer to page 5.

DRAINAGE

Good subsurface and surface drainage is essential to quality hot-mix asphalt pavements. Refer to pages 8-9.

TACK COAT

Refer to page 5.

AGGREGATE BASE CONSTRUCTION

In certain situations graded aggregate base construction may be desirable. Good subsurface and surface drainage is essential to quality hot-mix asphalt pavements. Refer to page 9.

HMA CONSTRUCTION

HMA shall be designed, mixed and constructed in accordance with the PENNDOT Specifications Publication 408/2003.

If several courses are desired or if job specifications require several courses, it is recommended that the first course be 3” minimum depth.

CONSTRUCTION DETAILS 4 (TRAFFIC CLASS 4)				
Subgrade Class	**Constructed Layer**	**Compacted Thickness**	**Design Level**	**SUPERPAVE Mix**
Good	Surface*	1.5"	100 gyrations	9.5 mm
	Base	3"	100 gyrations	19 mm
	Base	3"	100 gyrations	19 mm
Medium	Surface*	1.5"	100 gyrations	9.5 mm
	Base	3"	100 gyrations	19 mm
	Base	4.5"	100 gyrations	25 mm
Poor	Surface*	1.5"	100 gyrations	9.5 mm
	Base	4.5"	100 gyrations	25 mm
	Base	5"	100 gyrations	25 mm

*Note: SMA could be used as the surface course.

CONSTRUCTION DETAILS 4A (TRAFFIC CLASS 4)				
Subgrade Class	**Constructed Layer**	**Compacted Thickness**	**Design Level**	**SUPERPAVE Mix**
Good	Surface*	1.5"	100 gyrations	9.5 mm
	Base	3"	100 gyrations	19 mm
	Base	3"	100 gyrations	19 mm
Medium	Surface*	1.5"	100 gyrations	9.5 mm
	Base	2.5"	100 gyrations	19 mm
	Base	3.5"	100 gyrations	25 mm
	Aggregate Base	6"		
Poor	Surface*	1.5"	100 gyrations	9.5 mm
	Base	3"	100 gyrations	19 mm
	Base	4.5"	100 gyrations	25 mm
	Aggregate Base	8"		

PRINCIPAL ARTERIAL, COMMERCIAL OR INDUSTRIAL ROADS

*Note: SMA could be used as the surface course.

(INSERT PHOTO)

CONSTRUCTION DETAILS				
Subgrade Class		**COMPACTED THICKNESS**	**DESIGN LEVEL**	**SUPERPAVE Mix**
Good	Surface Course	1.5"	50 gyrations	9.5 mm
Medium	Level Course	1.5"	50 gyrations	9.5 mm
Poor	Base Course	2"	50 gyrations	12.5 mm

TENNIS & MULTI-USE COURTS, RUNNING TRACKS

SUBGRADE

Subgrade soils must be evaluated to determine the load-supporting characteristics. Refer to page 9.

The subgrade must be properly shaped to the desired section and elevation and shall be compacted. Refer to page 5.

TACK COAT

Refer to page 5.

HMA CONSTRUCTION

HMA shall be designed, mixed and constructed in accordance with PENNDOT Specifications Publication 408/2003.

The HMA may be placed with a mechanical paver or by hand, if the contractor elects. In either case, for tennis court construction, the finished course must not vary from line, grade, or cross-section more than 1/8" in 10' when measured in any direction. For running tracks, the finished course must not vary more than 1/4" in 10'.

Proprietary surfacing is available for tennis courts and running tracks. Most members of PAPA are familiar with the various materials and can provide information on them, or it may be necessary to contact the manufacturer directly.

DRAINAGE

The finished tennis court surface should slope 1" in 10', 0.83%, on a true plane from end to end, corner to corner, or side to side. Side to side is preferable for a playing surface and for construction. The surface should not slope to the net or away from the net in more than one direction.

A special mix other than 9.5 mm may be used for the surface course for running tracks. There are several resilient hot mixes available which combine rubber with regular aggregate plus a high asphalt content. Specifications and technical assistance are available from the firms that furnish the special aggregate.

HMA OVERLAYS (RESURFACINGS)

Asphalt overlays are the most common, practical, and economical way to salvage, strengthen, and modernize old pavements.

Properly designed, constructed and maintained hot-mix asphalt pavement resurfacings offer the following advantages:

1. Strengthen existing pavement structurally
2. Reduce maintenance appreciably

3. Extend service life appreciably
4. Allow use of roadway while improvements are in progress
5. Provide safer pavements
6. Improve ride quality and appearance
7. Reduced energy costs
8. Provide noise reduction

MULTIPLE LIFT RESURFACING CONSTRUCTION DETAILS			
	Average Compacted Thickness	**Design Level**	**SUPERPAVE Mix**
Surface Course	1.5"	Refer to Chart	9.5 mm
Base Course	Design Thickness	Refer to Chart	19.5 mm, 25 mm
Leveling (when required)	Variable Depth	Refer to Chart	9.5 mm*
Old Pavement			
Surface Course	1.5"	Refer to Chart	9.5 mm
Leveling Course	Variable Depth	Refer to Chart	9.5 mm
Old Pavement			

9. 100% recyclable

RESURFACING CONSIDERATIONS

HIGH VOLUME SINGLE LIFT RESURFACING CONSTRUCTION DETAILS			
	Average Compacted Thickness	**Design Level**	**SUPERPAVE Mix**
Surface Course	2"	Refer to Chart 1	12.5 mm
Old Pavement			
Surface Course	1.5"	Refer to Chart 1	9.5 mm
Old Pavement			

TACK COAT

Refer to page 5.
A tack coat of asphalt (usually emulsified asphalt) is applied to ensure bond between the existing surface and the asphalt overlay. It should be applied in an even, thin coat at a rate of application from 0.02 to 0.07 gal/yd^2 for asphalt residue. Excessive tack coat can cause slippage or can flush to the surface.

All longitudinal and transverse construction joints shall be properly tacked.
*If wedge and leveling course exceed 1.5”, consider using a 12.5 mm wearing course.

HMA CONSTRUCTION

HMA shall be designed, mixed and constructed in accordance with the PENNDOT Specifications Publication 408/2003.

OTHER USES FOR HMA

There are a wide variety of uses for HMA mixes and/or pavements that are not listed or shown elsewhere in this guide. The same basic principles used for constructing successful pavements would apply to installing pavements for other uses. Some pavement or mix modifications might be required, but are generally minor in nature. Some of the other uses for the product follow:

AIRFIELDS

- Runways
- Taxiways
- Holding Areas
- Heliports

MOTOR SPORTS RACE TRACKS

Specialty mixes not included in Chart 1: "Recommended Mixes for Normal HMA Applications" may be required. NAPA, the Asphalt Institute and automotive sanctioning bodies should be consulted during the design process.

INDUSTRIAL-COMMERCIAL
- Dock Surfaces
- Building Floors
- Material Storage Areas

PATCHING
- Maintenance for All Types of Pavements

RAILROADS
- HMA Ballast Underlayment
- Full-Depth Hot-Mix Asphalt

RECREATION
- Boat Ramps
- Athletic Fields
- Skate Board and Roller Blade Facilities

APPENDIX

MODEL SPECIFICATIONS

FOR SMALL PAVING JOBS

MODEL SPECIFICATIONS FOR SMALL PAVING JOBS

SPECIFICATIONS FOR PAVING

A. _____ WITH FULL-DEPTH ASPHALT CONCRETE*

1. **Scope:** Furnish and construct a Full-Depth asphalt pavement structure for a _____ _____ as specified.

A. GENERAL REQUIREMENTS

2. **Establishment of Grades:*** Grades shall be (will be) established by the contractor (owner) and the grade stakes shall be (will be) set to the desired elevation by the contractor (owner). In establishing the grades due allowances shall be (will be) made for existing improvements, proper drainage, adjoining property rights and good appearance.

3. **Preparation of Subgrade:*** All debris, vegetation, or other perishable materials shall be removed from the job site, except for trees or shrubs designated for preservation. The site to be paved shall be graded to the required section and all excess material removed from the location of the work. Material in soft spots shall be removed to the depth required to provide a firm foundation and shall be replaced with a material equal to, or better than, the best subgrade material on the site. The entire subgrade area shall be thoroughly compacted at the lowest moisture content at which a handful of the soil can be molded by a firm closing of the hand. The surface of the subgrade after compaction shall be hard, uniform, smooth, and true to grade and cross-section. If specified by the owner or his engineer prior to placing the base course, designated subgrade areas shall be treated with a soil sterilant at the rate specified by the manufacturer to prevent the growth of weeds. If specified, the subgrade shall be primed.

4. **Thickness of Structure:** On the prepared subgrade a plant-mixed asphalt base shall be laid in _____ course(s) to a compacted thickness of _____ millimeters (_____ inches). Placing of the plant-mixed asphalt surface course shall follow and be laid in a single course to a compacted thickness of _____ millimeters (_____ inches).

5. **Tack Coat:*** If specified by the owner (engineer), a tack coat shall be _____asphalt applied at the rate of _____ litre/m² (_____ gallons per square yard).

6. **Equipment, Materials, and Labor:*** The contractor shall provide the necessary equipment, materials, and labor to complete the job acceptable to the owner. Variations in the size and amount of equipment will depend on the size of the area being paved.

7. **Sampling and Testing:** If specified by the owner (engineer) the contractor shall furnish for test and analysis representative samples of the materials to be used in the work. Alternatively, if specified by the owner (engineer), the contractor shall provide certification that material furnished is in accordance with the contract. Sampling and testing shall be in accordance with the latest revisions of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM) Standard procedures for sampling and testing the materials being used in the project.

8. **Smoothness:** The surface of the completed work, when tested with a 3-m (10-foot) straightedge, shall not contain irregularities in excess of 6mm (¼ in.)

* See Notes to the Owner (Engineer).

B. MATERIALS

9. **Asphalt:** The asphalt for the plant mix shall be (type and grade) as specified by the owner (engineer) prior to the letting of the contract. The asphalt material for priming the subgrade shall be (type and grade) as specified prior to the letting of the contract. The asphalt material selected shall meet the requirements of the applicable table in Specifications for Paving and Industrial Asphalts (SS-2), the Asphalt Institute. A certificate of compliance with the specifications of the asphalt will be acceptable.

10. **Mineral Aggregate:** Asphalt Plant-Mix Base and Surface
(1) The mineral aggregate for asphalt plant-mix shall consist of coarse aggregate, fine aggregate, and, if needed, mineral filler. The coarse aggregate shall be sound, angular crushed stone, crushed gravel, or crushed slag. Uncrushed coarse aggregate may be used in base course mixtures if the mixture meets all design criteria. The fine aggregate shall be well graded, moderately sharp to sharp sands.

(2) The mineral aggregate and asphalt shall be combined in a mixing plant to meet the following gradations for asphalt concrete base and surface, as specified by the engineer prior to the letting of the contract.

Base and Surface Sieve Size	*Percent Passing by Weight
25.0mm (1 in.)	_____
19.0mm (3/4 in.)	_____
9.5mm (3/8 in.)	_____
4.75mm (No. 4)	_____
2.36mm (No. 8)	_____
600μm (No. 30)	_____
300μm (No. 50)	_____
150μm (No. 100)	_____
75μm (No. 200)	_____
Asphalt (percent by weight of total mix)	_____

C. CONSTRUCTION

11. **Spreading Base and Surface Courses: Asphalt Base and Surface**

(1) For all areas of more than 840m² (1,000 square yards), asphalt base and surface courses shall be spread and struck off with a paver. Any irregularities in the surface of the pavement course shall be corrected directly behind the paver. Excess material forming high spots shall be removed with a shovel or a lute. Indented areas shall be filled with hot mix and smoothed with a lute or the edge of a shovel being pulled over the surface. Casting of mix over such areas shall not be permitted.

(2) If it is impractical to use a paver or spreader box in areas of 840m² (1,000 square yards) or less, asphalt base and surface courses may be spread and finished by hand. Wood or steel forms, rigidly supported to ensure correct grade and cross-section, may be used. Placing by hand shall be performed carefully to avoid segregation of the mix. Broadcasting of the material shall not be permitted. Any lumps that do not break down readily shall be removed.

12. **Compaction, Asphalt Base and Surface:** Rolling shall start as soon as the hot-mix material can be compacted without displacement. Rolling shall continue until thoroughly compacted and all roller marks have disappeared.

In areas too small for the roller, a vibrating plate compactor or hand tamper shall be used to achieve thorough compaction.

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* Figures to be filled in. See Item 7, Notes to the Owner (Engineer).

13. **Method of Measurement:** The quantities to be paid for will be as follows:

    (1) *Preparation of Subgrade*—Total number of square metres (square yards) of subgrade actually prepared for covering with base material.

    (2) *Asphalt Mixture*—Total number of tonnes (tons) of asphalt mixture actually incorporated into the work.

14. **Basis of Payment:** The quantities enumerated in Section 13 will be paid for at the contract unit price bid for each item or at a lump-sum price bid for the job. Payment will be in full compensation for furnishing, hauling, and placing materials, for rolling, and for all labor and use of equipment, tools, and incidentals necessary to complete the work in accordance with these specifications.

NOTES TO THE OWNER (ENGINEER)

1. This specification is applicable for such small paving jobs as

   Parking Areas 4200m² (5,000 square yards) or less
   Driveways
   Service Stations
   Bicycle Paths
   Golf Cart Paths
   Sidewalks.

2. Full-Depth asphalt pavements are recommended for greater strength and durability.

3. **Article 2. Establishment of Grades**—If the contractor is to establish the grades, delete "will be" and "owner" wherever they appear in the first sentence. If the owner is to establish grades, delete "shall be" and "contractor".

4. **Article 5. Tack Coat**—From 0.25 to 0.7 litre/m² (0.05 to 0.15 gal/yd²) of diluted SS-1, SS-1h, CSS-1 or CSS-1h is recommended. The asphalt emulsion should be diluted with equal parts of water.

5. **Article 6. Equipment**—If the job is under the supervision of an engineer, the engineer should approve those pieces of equipment applicable to the job to which the specification will apply.

6. **Article 10. Mineral Aggregate-Asphalt Plant-Mix Base and Surface**—Asphalt mixes meeting the requirements of ASTM Standard Specification D 3515 are recommended. Asphalt mixes specified by local public agencies may be used if they have a history of satisfactory performance. Contact an Asphalt Institute engineer for information on local mixes.

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* See Notes to the Owner (Engineer).

Notes

Notes

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