COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 4 - New Construction/Reconstruction
(Limited Revisions)

Revision 1

July 2, 2002

CHANGES TO CHAPTER 4

Pages	**Changes**
Contents	List of Figures and Tables included.
4-3	Table 4-1. ‘Percent Trucks’ column math symbols were clarified.
4-6	Section 4.5.1.1.A, second and third paragraphs. Updated references to Chapter 6.
4-12	Figure 4-2. Deleted reference to Asphalt Treated Permeable Base (ATPB). Enlarged figure for clarity.
4-13	Table 4.4. ‘ESAL’ column math symbols were clarified.
4-15	Figure 4-3. Specifically reference Asphalt Treated Permeable Base (ATPB). Enlarged figure for clarity.
4-16	Table 4.5. ‘ESAL’ column math symbols were clarified. Table 4.5. First row of ‘Total HMA Thickness’ column in all cases updated to agree with new Chapter 6 guidance.

CHAPTER 4
NEW CONSTRUCTION/RECONSTRUCTION

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4.1 INTRODUCTION

This chapter describes the methods of selecting pavement thickness for new construction and reconstruction projects. Pavement design procedures are classified herein as conventional (Section 4.4) or as equivalent single axle load ESAL-based (Section 4.5), which was formerly issued as the *New York State Thickness Design Manual for New and Reconstructed Pavements* dated October 31, 1994.

4.2 PAVEMENT TYPE SELECTION

Each new construction or reconstruction project should be evaluated to determine the most appropriate type of pavement. The current pavement selection method, Pavement Type Selection Analysis, uses several factors for comparing suitable options, and is outlined in Chapter 3 of this manual. The method examines the project's life-cycle cost rather than only the first cost.

4.3 PAVEMENT DESIGN PROCEDURE DETERMINATION

Projects over 1.5 km in length, exclusive of bridges, should be designed in accordance with the ESAL-based design procedures given in Section 4.5. New pavement projects less than 1.5 km in length may be exempted by the Regional Design Engineer and may be designed in accordance with the conventional design procedures in Section 4.4.

Widening projects should use a pavement section that is consistent with the existing pavement design. Typically, this means that the thickness of each layer of the widened section should match the existing pavement. When the existing pavement layers are exceedingly thick, there may be a structural problem with the existing pavement. Refer to Chapter 2 of this manual for more information. It is also important that the effectiveness and continuity of any existing drainage layers be maintained or enhanced. The goal is to develop a widened section that responds the same to frost, traffic loads and other effects as the existing section does. See Chapter 5 of this manual for additional information about lane additions and widenings.

4.4 CONVENTIONAL PAVEMENT DESIGN

Conventional pavement design is based on both the amount of traffic volume and the percentage of trucks. Table 4-1 gives the pavement thicknesses that should be used for given traffic volumes.

Conventional Portland Cement Concrete (PCC) pavement should be built with 5.5 m long, unreinforced slabs when used on new construction projects. Designers working with older roads should be aware that some PCC pavements were built with reinforced 18 m (60-foot) and even 30 m (100-foot) slabs. When placed adjacent to existing slabs, the new pavement should match the existing pavement cross section, and the transverse joints should be made at the same locations as the existing joints. Refer to Standard Sheet M502-1 for reinforcement details and Chapter 8 of this manual for joint design. For PCC design, the first two slabs following the departure bridge approach slab should be reinforced PCC.

4.4.1 Conventional Pavement Design Procedure

1. Obtain the Annual Average Daily Traffic (AADT) and the Percent Trucks for the project from the Highway Sufficiency Ratings or from the Regional Planning Office.
2. If the project is an Interstate highway refer to the minimum requirements outlined below.
3. Determine the pavement thickness from Table 4-1.
4. If the pavement is hot mix asphalt (HMA) determine the SUPERPAVE top, binder, and base course items as given in Chapter 6 of this manual.
5. Determine the shoulder design based on guidelines in Chapter 7 in this manual.
6. Determine the drainage design, if needed, based on guidelines in Chapter 9 in this manual.

4.4.2 Interstate Highway Conventional Pavement Requirements

For the Interstate system, the following are minimum requirements for conventional pavement design.

1. The minimum PCC pavement thickness is 225 mm.
2. If HMA pavement is selected, use ≥ 10 % truck traffic for the pavement design.
3. The joint between PCC mainlines and HMA ramps should be at the first transverse joint beyond the separation of mainline and ramp pavements. The change in pavement type should be at right angles to the ramp.
4. If an interchange ramp is to built of HMA pavement it should have a minimum combined thickness for top, binder and base courses of 155 mm. The ramp pavement thicknesses should also satisfy the values shown in Table 4-1. When selecting pavement thickness or type (HMA or PCC) for ramps, consideration should be given to heavy truck destination points in the immediate vicinity, such as truck terminals or refueling areas, and the pavement thickness increased accordingly.
5. PCC pavement may be used on high speed ramps 80 km/h or greater, to preserve continuity with a PCC paved mainline. PCC pavement should be used on lower speed ramps less than 80 km/h, when shoving of the HMA pavement is anticipated.

Table 4-1 Conventional Pavement Thickness Guide

Annual Average Daily Traffic AADT[1]	Percent Trucks	Subbase Course (all Pavements)	Portland Cement Concrete Pavement	Hot Mix Asphalt Pavement	
				Base Course	Top & Binder Courses Combined[2]
Over 10,000 Vehicles	10 % or more	300 mm	250 mm	150 mm	90 mm
	less than 10 %			125 mm	
6,000 to 10,000	10 % or more	300 mm	225 mm	125 mm	90 mm
	less than 10 %			100 mm	
4,000 to 5,999	All	300 mm	Not Applicable	75 mm	90 mm
Under 4,000 Vehicles	All	300 mm	Not Applicable	75 mm	80 mm

[1] See Section 4.5.1.1.B for AADT definition.
[2] This is for SUPERPAVE HMA - see Chapter 6 of this manual for individual course thicknesses.

4.5 ESAL-BASED PAVEMENT DESIGN

ESAL-based pavement design is based on the *American Association of State Highway and Transportation Officials (AASHTO) 1993 Guide for the Design of Pavement Structures,* referred to in this manual as the *1993 AASHTO Pavement Design Manual.* Equivalent single axle loads (ESAL) are used for determining pavement thickness and the design relies on using a treated open-graded permeable base layer with continuous edge drains in the pavement structure to provide positive drainage.

The key input variable in the ESAL-based design process is the anticipated amount of heavy truck traffic. The truck traffic is measured and converted to a number of 80 kN ESALs. Section 4.5.1 provides the steps for calculating ESALs using available NYSDOT traffic data.

The *1993 AASHTO Pavement Design Manual* provides a reasonable methodology in designing for adequate structural capacity of the pavement structure. However, it neglects to account for lack of uniform support in the subgrade due to nonuniform, frost-susceptible soils, or to provide adequate support for construction equipment due to unstable subgrade soils. Numerous subgrade improvement methods have been used by NYSDOT in the past to account for these situations.

For PCC pavements the *1993 AASHTO Pavement Design Manual* method was modified for NYS conditions. A mechanistic-empirical design procedure (M-E procedure) was used to predict pavement performance. A nondimensional performance model for New York State was developed using pavement response to the combined effects of temperature and traffic loading, calibrated with actual pavement performance and 90 % reliability. Miner's hypothesis was used to sum the damage caused by traffic and environmental loading. Pavement response was determined with actual physical dimensions, material properties, soil support, temperature gradients, and traffic from New York State DOT pavements.

The M-E procedure uses principles of engineering mechanics to calculate pavement response and relate them to rates of deterioration. Therefore, once the M-E procedure has been calibrated with serviceability vs. time histories of pavement structures, developing possible pavement performance for conditions outside the study area by calculating stresses is feasible. The PCC thicknesses for Table 4-4 were developed using the M-E procedure.

For flexible (HMA) pavements, the other input variable is the load carrying capability of the materials below the pavement or the Subgrade Resilient Modulus (M_r). This modulus is dependent on the characteristics of the underlying soil. The value of the modulus for given locations may be obtained from the Regional Geotechnical Engineer. The HMA thicknesses for Table 4-5 were derived from the *1993 AASHTO Pavement Design Manual* and include the overall HMA thickness exclusive of the permeable base layer.

ESAL-based pavement is designed to be a long lasting, low maintenance, smooth riding pavement system. Major component differences compared to conventional pavement designs account for increased pavement life as follows:

1. Thicker PCC pavement slabs (up to 325 mm thick).
2. Thicker flexible pavement subbase course(s) (up to 900 mm thick).
3. Locating the longitudinal joint between shoulders and driving lane 0.6 m outside of the travel lane.
4. Subsurface pavement drainage via a 100 mm thick treated permeable base with continuous edge drains outletting approximately every 75 m.
5. Subbase is considered impermeable, so water drains through permeable base layer and does not penetrate subbase.

Currently in New York State, pavements are designed for a 50-year life. The 50-year life expectancy is based on observations of the longevity of European pavements and our own history of pavements in New York State. Our first ESAL-based pavements were built in 1993, and have performed quite well since then. This longer 50-year design life is predicated on the structural integrity of the pavement structure as a whole. A flexible pavement obviously will require some kind of rehabilitation (probably periodic thin overlays or recycling of the existing asphalt due to the aging process) during this 50-year period. This should be incorporated into the life-cycle cost analyses. Rigid pavements will require preventive maintenance and minor rehabilitation (such as joint resealing and surface grinding to restore friction) during the 50-year design life.

4.5.1 ESAL Calculation

ESALs, or 80-kN Equivalent Single Axle Loads, is an important input parameter for the pavement thickness design tables. Traffic on a pavement structure includes numerous types of vehicles with varying weights and axle configurations (mixed traffic). The anticipated traffic damage over a pavement's entire design life from all load combinations must be converted to a fixed traffic factor or an ESAL, to be incorporated into the design equations from the *1993 AASHTO Pavement Design Manual*.

NYSDOT uses the AASHTO "simple" method for obtaining ESALs for pavement design. This method uses a Truck Equivalency Factor to account for all trucks using the pavement (FHWA Vehicle Classes 4 through 13). FHWA's 13 category vehicle classification system, also known as FHWA scheme F, categorizes vehicles according to axle geometry and vehicle type. The classification system assigns motorcycles to class 1, with the classes representing progressively heavier vehicles up to class 13 for trucks with 7 axles or more and multiple trailers. Class 4 vehicles are buses. Class 5 vehicles are 2 axle, 6 tire single unit trucks. Vehicles with heavier axle loads do exponentially more damage to the pavement structure and this loading damage accumulates over the design life of the pavement. Lighter vehicles (motorcycles, passenger cars, etc.) make little contribution to damaging the pavement structure.

ESALs are a measurement of load repetitions which accumulate and cause pavement damage. The pavement thickness is designed for the projected number of ESALs over the pavement's design life. ESALs calculated for PCC pavements are not the same as those calculated for HMA pavement due to the Truck Equivalency Factor. For the same road section, ESALs calculated for rigid pavement are about 40 % greater than ESALs calculated for flexible pavement.

AASHTO has another procedure, the "rigorous" method, which calculates site specific equivalency factors for each vehicle classification. Presently there is not sufficient data to use the "rigorous" method and only the “simple” method is used to calculate ESALs.

4.5.1.1 Inputs for ESAL Calculation

Most inputs for ESAL calculation are found in the NYSDOT Highway Sufficiency Ratings, which is arranged by New York State route number, county, and reference marker number. If the data in the Highway Sufficiency Ratings is more than 3 years old, contact the Regional Planning Office for a classification count and the percentage of heavy trucks. Contact the Regional Planning Group, the Main Office Data Services Bureau, or the Geotechnical Engineering Bureau with questions about traffic information or data. All traffic inputs are described in the following pages.

F. Pavement Design Life

As defined by AASHTO, this is the initial performance period of the pavement structure in years. The design life is the useful life of the pavement structure and drainage system after which time the road may need total reconstruction from the subbase up. **For ESAL-based pavement design, use 50 years as the design life to calculate the ESAL value to determine the total thickness of the pavement, exclusive of the permeable base and subbase layers.** Paragraphs B through H in Section 4.5.1.1 provide guidance on calculating the site-specific 50-year ESAL value. For PCC pavements, use the 50-year ESAL value to determine the slab thickness from Table 4-4. For HMA pavements, use the 50-year ESAL value to determine the total HMA thickness (combined thickness of base, binder, and top courses) from Table 4-5.

CAUTION: Design life should not be confused with the service life of pavements as explained in the *Pavement Rehabilitation Manual, Volume II, Treatment Selection*, (Appendix 5A of this manual). **For HMA designs**, calculate the 20-year ESAL count to determine the aggregate size and pay item of each course (see Chapter 6, HMA Item Selection Guidelines) using the following specific values, as well as the appropriate values from paragraphs B through F in Section 4.5.1.1:

- Annual Truck Weight Growth Rate = 0.5%
- Annual Truck Volume Growth Rate = 2.0%
- Percent Trucks in Design Lane: 1 lane = 100; 2 lanes = 85; 3 lanes = 70; 4 lanes = 60.

The sum of all HMA course thicknesses should equal or exceed the total HMA thickness required by Table 4-5 based on the 50-year ESAL value. See Chapter 6, Special Note Development, for the wording of the special note required in the proposal, which conveys to the Contractor the Performance Graded Binder (PGB) grade and the 20-year ESAL level.

G. Initial AADT (Average Annual Daily Traffic)

This is the 24-hour two-way vehicle count in all lanes for a pavement structure when opened to traffic. Choose the highest AADT value provided in the Highway Sufficiency Ratings within the project limits.

H. Percent Heavy Trucks (FHWA Class 4 or Greater)

This is the percentage of vehicles in the average daily traffic flow that are in FHWA Class 4 or higher. This percentage is assumed to remain constant over the design life unless other information is available, such as a proposed new truck route or a new business requiring a lot of trucking, in which case the percentage should be modified.

I. Percent Trucks in Design Direction

This is a directional distribution factor applied to the two-way AADT to account for any variations in truck traffic volumes or truck weights by direction. Normally, this factor is

50 percent, but in special cases where one direction of travel has either larger traffic volume or heavier vehicles, this factor may increase. Request a classification count for a specific site for a more accurate directional distribution factor.

J. Percent Trucks in Design Lane

This is a lane distribution factor which accounts for the percentage of trucks in the design lane. On a multilane roadway, truck traffic will be found in all lanes, but only the lane with the majority of truck traffic is called the "design lane". The design lane is typically the driving lane or the right lane and the pavement design for the other lanes is based on this lane. Table 4-2 lists the distribution factors for Percent Truck in Design Lane which the *1993 AASHTO Pavement Design Guide* recommends. The designer may wish to refine these values by requesting a classification count.

Table 4-2 Percent Trucks in Design Lane

Number Of Lanes In Each Direction	Percent Of Trucks In Design Lane
1	100
2	80-100
3	60-80
4	50-75

F. Truck Equivalency Factor (ESALs/Truck)

This is a weighted average which represents the number of 80-kN ESAL applications caused by a single passage of an average heavy vehicle. Equivalency factors may vary by as much as a factor of 2, depending on local industry, highway classification, and pavement type. The factors listed in Table 4-3 should generally be used unless the Regional Planning Office indicates that local truck traffic warrants adjusting the factors. These factors are based on weight data obtained from the limited number of weigh-in-motion sites in New York State and may be recalculated in the future when more data becomes available.

Table 4-3 Truck Equivalency Factor For ESAL Calculation

FHWA Vehicle Classifications	Flexible Pavement (HMA)	Rigid Pavement (PCC)
4 - 13	1.35	1.85

G. Annual Truck Volume Growth Rate

Expressed as a percent, this is used to specify the anticipated annual growth rate of the truck traffic volume compounded over a pavement's design life. Because this rate is compounded, the ESALs accrue quickly over 50 years, so the designer should be careful when selecting a value. Typical values are between 0 % and 2 % per year. The annual traffic volume growth rate for the general traffic stream may be used if no values are available for trucks alone. These growth rates are calculated every year based on the previous 15 years of traffic volume and are tabulated by Region and functional class. Contact the Regional Planning Group for the annual truck volume growth rate. When no other information is available use a rate of 1%.

H. Annual Truck Weight Growth Rate

The Annual Truck Weight Growth Rate is a factor which accounts for the increase in truck weights over time. It is expressed as a percentage and typically ranges from 0 % to 4% per year. A high growth rate can cause a dramatic increase of ESALs over the life of the pavement structure. NYSDOT does not currently have enough data to predict the increase of truck weights. When no other information is available use a rate of 0.5 %.

4.5.1.2 ESAL Calculation Worksheet

Use the work sheet below to calculate the total ESAL count using AASHTO's "simple" method for a compound traffic volume growth rate. This ESAL count is used to find the pavement thickness and for SUPERPAVE calculations. Contact the Pavement Design Services Group of the Geotechnical Engineering Bureau for an electronic spreadsheet of this worksheet or download the spreadsheet located on the Intradot: CADD Innovation Section/Quattro Pro File Exchange/esal vx.wb3.

Figure 4-1 ESAL Calculation Worksheet for the "Simple" Method

Input Parameters:

1. Design Life = _______________years
2. Initial AADT = _______________vehicles
3. Percent Heavy Truck (Class 4 or greater) = _______________ %
4. Percent Trucks in Design Direction = _______________ %
5. Percent Trucks in Design Lane = _______________ %
6. Truck Equivalency Factor = _______________
7. Annual Truck Volume Growth Rate = _______________ %
8. Annual Truck Weight Growth Rate = _______________ %

Traffic Analysis for Pavement Design:

9. Traffic Volume Growth Factor
   $[1 + \text{Item } 7]^{(\text{Item } 1 - 1)}$ = _______________
10. Truck Growth Factor
   $[1 + \text{Item } 8]^{(\text{Item } 1 - 1)}$ = _______________
11. Design Year AADT
   Item 2 x Item 9 = _______________
12. Average AADT
   (Item 2 + Item 11) / 2 = _______________
13. Design Year Truck Factor
   Item 6 x Item 10 = _______________
14. Average Truck Factor
   (Item 6 + Item 13) / 2 = _______________
15. AADT in One Direction
   Item 12 x Item 4 = _______________
16. Truck AADT in One Direction
   Item 15 x Item 3 = _______________
17. Daily 80 kN (18 kip) ESAL Count
   Item 16 x Item 14 = _______________
18. Total 80 kN (18 kip) ESAL Count
   Item 17 x 365 x Item 1 x Item 5 = _______________

4.5.2 **PCC Pavement**

The design of PCC pavement in New York State is based on a mechanistic-empirical approach as described in Section 4.5. This design method should be used in close conjunction with Chapter 8 of this manual, PCC Standard Sheets M502 series, and Section 502 of the NYSDOT Standard Specifications.

4.5.2.1 PCC Pavement Design Procedure

The steps for designing an ESAL-based PCC pavement are as follows:

1. Divide the project into different sections depending on traffic volumes and driving lane widths.
2. Calculate ESALs - see Section 4.5.1.
3. Determine the type of shoulders to be used - see Chapter 7 of this manual. Note one side of the road may have a PCC shoulder and other side an HMA shoulder.
4. Determine the driving lane slab width - see Section 4.5.2.2 below.
5. Determine pavement thickness from Table 4-4 below based on ESALs and lane width.
6. Determine the maximum tie bar spacing based on the number of lanes, whether it is a shoulder/lane joint, and either PCC or HMA shoulders from the Longitudinal Tie Bar Maximum Spacing Table in Standard Sheet M502-11. If the number of lanes changes then the tie bar spacing should change.
7. Determine dowel bar diameter based on pavement thickness from the Transverse Dowel Bar Diameter Table in Standard Sheet M502-11.
8. Select a drainage system, including the type of permeable drainage layer, and outletting protocol as shown in Section 9.3 of this manual. Where drainage outletting is difficult see Section 9.2.1 of this manual.
9. Layout the transverse and longitudinal joints according to instructions in PCC Standard Sheet M502-11. If there will be utility structures in the lanes, follow the utility isolation and joint layout instructions in PCC Standard Sheet M502-17. Questions regarding transverse and longitudinal joints should be addressed to the Field Engineering 2 Section of the Main Office Materials Bureau.

4.5.2.2 PCC Pavement Driving Lane Slab Width and Length

The recommended driving lane slab width is 4.2 m, which amounts to a standard 3.6 m lane plus a 0.6 m extension onto the shoulder. For a 2-lane highway (one lane in each direction), both lanes should have a 4.2 m slab width. With multilane highways, the 4.2 m slab width should only be used for the right hand outside lane and not for the center or left lanes. This is because there is more traffic in the right hand lane (especially truck traffic), so this lane gets the most damage. The joint at the pavement edge, between the driving lane and the shoulder, deteriorates quicker than the other joints, since traffic runs close to or over the joint. The wide slab (4.2 m) spreads the load over a larger area and moves the pavement edge onto the shoulder, reducing the stresses and thus the distress at the edge of the pavement. To account for the large magnitude of stresses at the pavement edge, narrow slabs (3.6 m) must be thicker than wide slabs (4.2 m). A wide thin slab can handle a similar number of load applications as a narrow thick slab.

Sometimes it is not possible to construct a wide driving lane slab (4.2 m), so a standard slab width (3.6 m) is used. If this occurs for transitions to exit and entrance ramps, where the driving lane changes to a middle or center lane, do not change the slab thickness, keep it the same as the rest of the project. Ramps have less ESALs than the highway mainline. For other cases, contact the Field Engineering 1 Section of the Main Office Materials Bureau to assist with the design, since the slab length may have to be changed to compensate for the slab width change.

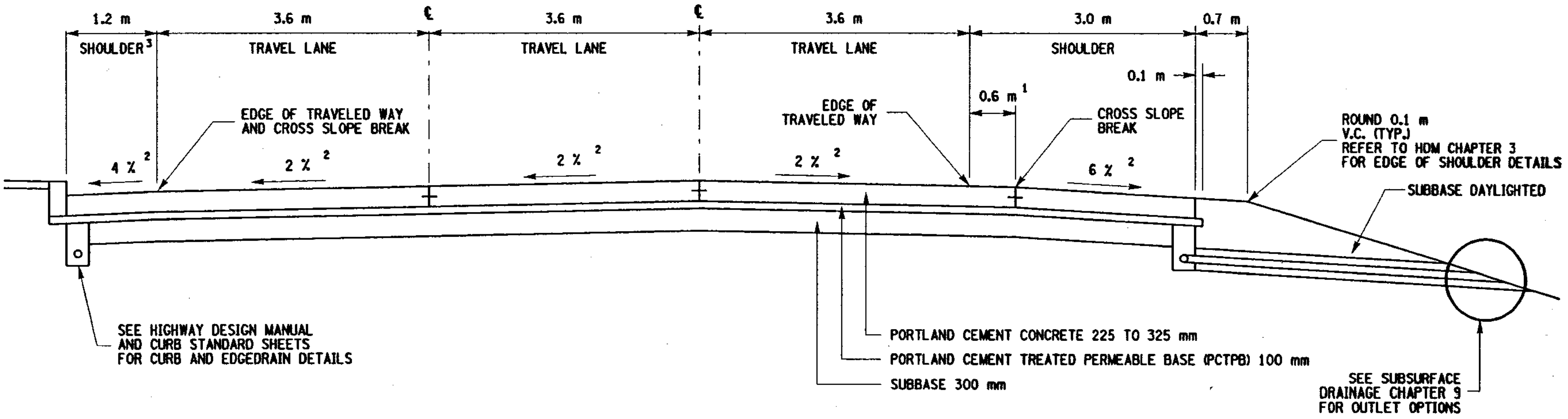
For typical applications, the driving lane slab should be longitudinally tied to the shoulder slab, whether it is a 4.2 m or 3.6 m wide slab. Although for special cases untied shoulders and HMA shoulders may be used, they may cause premature deterioration of both the shoulder and the driving lane compared with the tied shoulder case. Chapter 8 of this manual discusses when untied longitudinal joints are appropriate. The PCC thicknesses in Table 4-4 are valid for tied or untied shoulders and either PCC or HMA shoulders.

The shoulder and the abutting travel lane may be placed in a single pour as discussed in Section 7.3 of this manual. The typical slab length is 5.5 m, but this may be reduced to a minimum of 3.5 m to satisfy site conditions such as utilities or interruptions in the pavement. The slab aspect ratio (width/length) must conform to that shown on Standard Sheet M502-17, Note 3a. The maximum slab width and length are both 5.5 m.

4.5.2.3 Typical PCC Pavement Section

A typical PCC pavement section is shown in Figure 4-2. This typical section is shown for reference purposes for the text only. Refer to Standard Sheet M502-11and HDM Chapter 3 for further details and guidance on the development of typical sections.

FIGURE 4-2 TYPICAL PORTLAND CEMENT CONCRETE PAVEMENT SECTION



THE DIMENSIONS SHOWN ARE TYPICAL ONLY AND THE DETAILS ARE SHOWN TO GIVE THE DESIGNER AN IDEA OF WHAT THE OVERALL SECTION LOOKS LIKE.

1. THE DRIVING LANE SLAB WIDTH IS 4.2 m, OF WHICH 3.6 m IS THE TRAVEL LANE AND 0.6 m IS PART OF THE SHOULDER.
2. REFER TO THE HIGHWAY DESIGN MANUAL, CHAPTERS 2 AND 3, FOR THE PROPER CROSS SLOPE AND FUTHER GUIDANCE ON THE DEVELOPMENT OF TYPICAL SECTIONS.
3. IN THIS CASE THE SHOULDER (1.2 m) AND THE TRAVEL LANE (3.6 m) ARE POURED AS ONE SLAB WITH NO LONGITUDINAL JOINT IN BETWEEN THEM. SEE SHOULDER CHAPTER 7 FOR MORE INFORMATION.

4.5.2.3 PCC Pavement Thickness

The pavement thickness for all adjacent lanes is dependent on the amount of traffic (ESALs) and the driving lane slab width, and is given in Table 4-4 below. Use a minimum slab thickness of 250 mm for all interstate highways.

Table 4-4 PCC Thickness Table

80-kN ESALs	**PCC Slab Thickness 4.2 m driving lane slab width**	**PCC Slab Thickness 3.6 m driving lane slab width**
millions	**mm**	**mm**
ESALs ≤ **22**	225	225
22 < ESALs ≤ **36**	225	250
36 < ESALs ≤ **65**	225	275
65 < ESALs ≤ **100**	250	300
100 < ESALs ≤ **165**	275	325
165 < ESALs ≤ **250**	300	325[1]
250 < ESALs ≤ **400**	325	325[1]

[1] For ESALs over 165 million, 3.6 m untied slabs may not be used for the right hand driving lane. Use either 3.6 m tied slabs, 4.2 m untied slabs, or 4.2 m tied slabs.

4.5.3 **HMA Pavement**

ESAL-based design of HMA pavement is based on the SUPERPAVE system in New York State. This section describes the steps for designing a full depth HMA pavement for new construction/reconstruction and provides the overall asphalt thickness of the pavement and subgrade. Chapter 6 of this manual, provides guidance on determining the thickness of the individual SUPERPAVE HMA courses that make up the overall asphalt pavement thickness.

4.5.3.1 HMA Pavement Design Procedure

The steps for designing an ESAL-based HMA pavement are as follows:

1. Divide the project into different sections depending on significant traffic volume differences and complete the following steps for each section.
2. Calculate ESALs - see Section 4.5.1.
3. Determine the type of shoulders to be used - see Chapter 7 of this manual.
4. Determine the subgrade resilient modulus, M_r - see Section 6.6.2 of this manual for a description of M_r and contact the Regional Geotechnical Engineer for an M_r value.
5. Determine pavement thickness from Table 4-5 based on ESALs.
6. Select a drainage system, including the type of permeable drainage layer, and outletting protocol as shown in Section 9.3 of this manual. Where drainage outletting is difficult see Section 9.2.1 of this manual.
7. Select the individual SUPERPAVE top, binder, and base course items according to the Item Selection Guidelines in Chapter 6 of this manual.

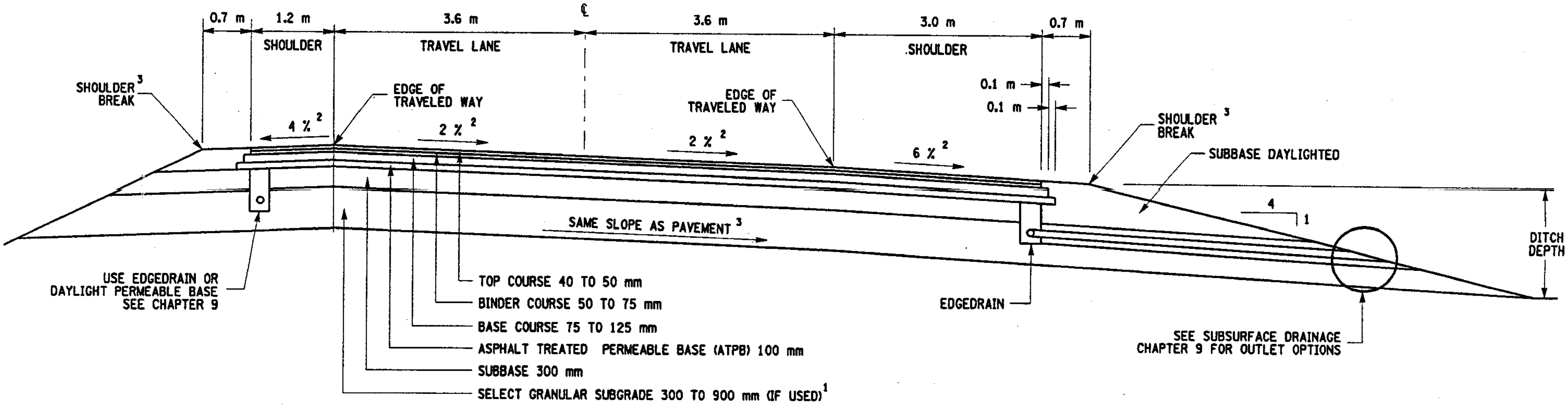
Questions regarding HMA pavement design should be addressed to the Field Engineering 2 Section of the Main Office Materials Bureau.

When Select Granular Subgrade is utilized, the lateral limit shall be at daylight on embankment slopes or at the extension of the ditch backslope in cut sections. The thickness shall be held constant under the traveled way. The bottom of the Select Granular Subgrade should be parallel to the bottom of the subbase as shown in Figure 3-3 of HDM Chapter 3.

4.5.3.2 Typical HMA Pavement Section

A typical HMA pavement section is shown in Figure 4-3. This section is shown for reference purposes for the text only. The HDM Chapter 3 contains guidance on the development of typical sections.

FIGURE 4-3 TYPICAL HOT MIX ASPHALT PAVEMENT SECTION



THE DIMENSIONS SHOWN ARE TYPICAL ONLY AND THE DETAILS ARE SHOWN TO GIVE THE DESIGNER AN IDEA OF WHAT OVERALL SECTION LOOKS LIKE.

1. SEE CHAPTER 6 FOR MORE INFORMATION OR CONTACT REGIONAL GEOTECHNICAL ENGINEER FOR NECESSITY AND THICKNESS OF SELECT GRANULAR SUBGRADE. DAYLIGHT SELECT GRANULAR SUBGRADE ONTO EMBANKMENT SLOPES OR AT THE EXTENSION OF THE DITCH BACKSLOPE IN CUT SECTIONS.
2. REFER TO THE HIGHWAY DESIGN MANUAL, CHAPTERS 2 AND 3, FOR THE PROPER CROSS SLOPE AND FURTHER DEVELOPMENT OF TYPICAL SECTIONS.
3. REFER TO THE HIGHWAY DESIGN MANUAL, CHAPTER 3, FOR SUBGRADE GRADE CHANGES AND EDGE OF SHOULDER DETAILS.

4.5.3.3 HMA Pavement Thickness

The pavement thickness <u>for all lanes</u> is dependent on the subgrade resilient modulus, M_r, and the amount of traffic in the driving lane (ESALs) and is given in Table 4-5 below. Contact the Regional Geotechnical Engineer to obtain the M_r design value, and also when site conditions would make it difficult to provide the required subbase course and/or select granular subgrade layer thicknesses.

Table 4-5 HMA Thickness Table

M_r = 28 MPa

80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ **2**	165	0
2 < ESALs ≤ **4**	175	0
4 < ESALs ≤ **8**	200	0
8 < ESALs ≤ **13**	225	0
13 < ESALs ≤ **23**	250	0
23 < ESALs ≤ **45**	250	150
45 < ESALs ≤ **80**	250	300
80 < ESALs ≤ **140**	250	450
140 < ESALs ≤ **300**	250	600

M_r = 34 MPa

80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ **4**	165	0
4 < ESALs ≤ **7**	175	0
7 < ESALs ≤ **13**	200	0
13 < ESALs ≤ **23**	225	0
23 < ESALs ≤ **40**	250	0
40 < ESALs ≤ **70**	250	150
70 < ESALs ≤ **130**	250	300
130 < ESALs ≤ **235**	250	450
235 < ESALs ≤ **300**	250	600

M_r = 41 MPa

80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ **6**	165	0
6 < ESALs ≤ **11**	175	0
11 < ESALs ≤ **20**	200	0
20 < ESALs ≤ **35**	225	0
35 < ESALs ≤ **60**	250	0
60 < ESALs ≤ **110**	250	150
110 < ESALs ≤ **200**	250	300
200 < ESALs ≤ **300**	250	450

M_r = 48 MPa

80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ **8**	165	0
8 < ESALs ≤ **16**	175	0
16 < ESALs ≤ **30**	200	0
30 < ESALs ≤ **50**	225	0
50 < ESALs ≤ **85**	250	0
85 < ESALs ≤ **160**	250	150
160 < ESALs ≤ **300**	250	300

M_r = 55 MPa

80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ **12**	165	0
12 < ESALs ≤ **20**	175	0
20 < ESALs ≤ **40**	200	0
40 < ESALs ≤ **65**	225	0
65 < ESALs ≤ **115**	250	0
115 < ESALs ≤ **215**	250	150
215 < ESALs ≤ **300**	250	300

M_r = 62 MPa

80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ **15**	165	0
15 < ESALs ≤ **30**	175	0
30 < ESALs ≤ **50**	200	0
50 < ESALs ≤ **90**	225	0
90 < ESALs ≤ **150**	250	0
150 < ESALs ≤ **300**	250	150

4.6 REFERENCES

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