Chapter 4
Thickness Design

GENERAL CONSIDERATIONS

Several procedures can be used to calculate the thickness of the proposed asphalt pavement. All are based on the volume and weight of the traffic that will use the facility and on the load-supporting capability of the underlying soil.

The AASHTO Road Test and other studies have indicated that heavy-vehicle wheel loads cause much greater damage to roads than do light loads. Thus, where large volumes of traffic with heavily loaded trucks are anticipated, an in-depth analysis of the pavement thickness is important. Because all of the higher functional classifications have the potential for heavy loadings, a traffic analysis is an important part of the preparation for thickness computations. Similarly, a knowledge of the load-bearing capability of the soil is an important aspect of the structural design process. The lack of a soil study with appropriate corrective action could significantly shorten the life of a poorly drained pavement.

All of the design procedures available for a structural thickness analysis cannot be included here. Additional information is included in The Asphalt Institute's Thickness Design Manual (MS 1) and their Simplified and Abridged Version published in Information Series No. 18 (IS-181). Another reference is The AASHTO Guide for Design of Pavement Structures, 1986. These guides are based on mechanistic/empirical design models, and they use Nomographs to attain pavement thickness. Several computer programs for designing pavements (including Asphalt Institute and AASHTO programs) are also available. The APAI or your contractor can help you with design questions.

PAVEMENT THICKNESS DESIGN TABLES

Future traffic assignments can be rather nebulous and are subject to many external influences. Some areas see no growth over a design period. Therefore, common practice is to group categories of traffic into classes. Similarly, it has been found that, based on a local knowledge, soil-supporting values can be grouped into classifications of poor, moderate, and good. These classifications (see Chapter 3) provide an opportunity to use pavement thickness design tables rather than more detailed formula procedures. These tables have been prepared by experts in the industry to simplify the process for engineers, technicians, and architects who prepare a pavement design.

Design Procedure

Tables 4-1 through 4-5 can be used directly to select design thicknesses from the design input factors. In order to use the tables, appropriate traffic and subgrade classes must be selected as follows.

Traffic

The design procedure separates traffic into six classes (I through VI). Each class is defined by the number of autos per day, the average daily number of heavy trucks expected on the facility during the design period, and the type of street or highway. Traffic classifications are presented in Chapter 3. The pavement thicknesses given in the tables of this and the following chapter are based on the average daily traffic (ADT) values over a 20-year design period. Heavy trucks are described as two-axle, six-tire vehicles or larger.

Soils

It is desirable to have laboratory tests on the subgrade soil. However, if tests are not available, a design may be based on careful field examinations by an engineer. Soils may be classified as good, moderate, or poor or by a CBR value. Soil classifications are presented in Chapter 3. If a soil CBR value lies between those given in the classifications, the lower classification is used.

Design Steps

The following steps can be used to determine a pavement thickness.

1. From the known average daily traffic, determine the total number of trucks over the design period. Using this information, select the traffic classifications (Class I through VI) from Chapter 3.

2. Select a subgrade class (good, moderate, or poor) from Chapter 3 using soil data from the project. If no soil information is known, use the poor classification for the subgrade.

3. Select a design thickness from Tables 4-1 through 4-5 using the selected traffic class and subgrade class.

Design Example

- A collector street is estimated to carry 500 vehicles and 20 trucks a day. Traffic class III is selected using Chapter 3.

- No soil data is known, so the engineer selects the poor soil classification.

- The total design thickness selected from Table 4-2 is 7-1/2 inches. The base course is 6 inches, and the surface course is 1-1/2 inches.

Residential Streets

The primary function of residential streets is to provide access to abutting property. This classification consists of the largest portion of the street and road network and provides the linkage to connect to higher types of facilities. Motorists' speeds may be low, or higher, depending on the standards to which the specific facility is designed.

Most trips on residential streets are short, and traffic volumes are low. Truck traffic is usually limited to vehicles that provide residential services such as trash pickup, moving vans, heating oil delivery, etc.

Table 4-1. Thickness Design: Residential Streets

A. For Asphalt Concrete Base Pavements

Design Criteria*			Thickness in Inches Asphalt Concrete		
Traffic Class (ADT)	Subgrade Class	CBR	Base	Surface	Total
II (50-200 ADT)	Good	9	4.0	1.0	5.0
	Moderate	6	5.0	1.0	6.0
	Poor	3	5.5	1.5	7.0
III (201-700 ADT)	Good	9	4.0	1.5	5.5
	Moderate	6	5.0	1.5	6.5
	Poor	3	6.0	1.5	7.5

B. For Untreated Aggregate Base Pavements

Design Criteria*			Thickness in Inches			
Traffic Class (ADT)	Subgrade Class	CBR	Untreated Aggregate Base	Asphalt Concrete Base	Asphalt Concrete Surface	Total
II (50-200 ADT)	Good	9	5.0	.0	3.0	8.0
	Moderate	6	8.0	.0	3.0	11.0
	Poor	3	8.0	2.0	2.0	12.0
III (201-700 ADT)	Good	9	7.0	.0	3.0	10.0
	Moderate	6	8.0	2.0	2.0	12.0
	Poor	3	8.0	3.0	2.0	13.0

**See chapter 3 for traffic and soil class details*

Collector Streets

Collector or feeder streets connect the residential street system with arterial routes. This classification of street serves dual functions of both land access and through-traffic movement. The mileage of collectors in any one jurisdiction may be very small. Generally, collectors have moderate amounts of low-to-intermediate-speed traffic, including some bus traffic, and heavy trucks.

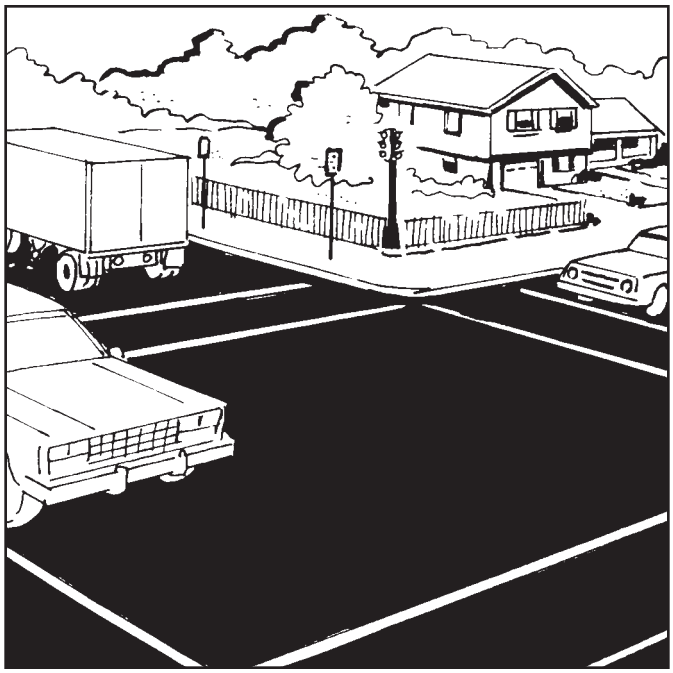


Table 4-2. Thickness Design: Collector Streets

A. For Asphalt Concrete Base Pavements

Design Criteria*			Thickness in Inches Asphalt Concrete		
Traffic Class (ADT)	Subgrade Class	CBR	Base	Surface	Total
II (50-200 ADT)	Good	9	4.0	1.0	5.0
	Moderate	6	5.0	1.0	6.0
	Poor	3	5.5	1.5	7.0
III (201-700 ADT)	Good	9	4.0	1.5	5.5
	Moderate	6	5.0	1.5	6.5
	Poor	3	6.0	1.5	7.5
IV (1,501-4,500 ADT)	Good	9	5.5	2.0	7.5
	Moderate	6	6.5	2.0	8.5
	Poor	3	7.5	2.0	9.5

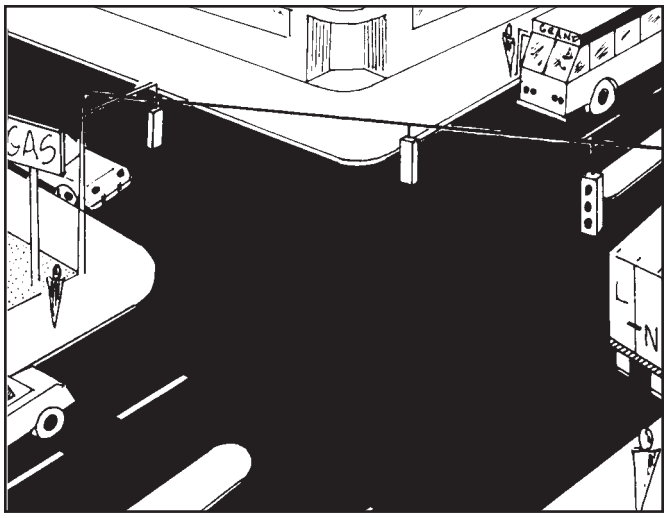
B. For Untreated Aggregate Base Pavements

Design Criteria*			Thickness in Inches			
Traffic Class (ADT)	Subgrade Class	CBR	Untreated Aggregate Base	Asphalt Concrete Base	Asphalt Concrete Surface	Total
II (50-200 ADT)	Good	9	5.0	.0	3.0	8.0
	Moderate	6	8.0	.0	3.0	11.0
	Poor	3	8.0	2.0	2.0	12.0
III (201-700 ADT)	Good	9	7.0	.0	3.0	10.0
	Moderate	6	8.0	2.0	2.0	12.0
	Poor	3	8.0	3.0	2.0	13.0
IV (1,500-4,500 ADT)	Good	9	8.0	3.0	2.0	13.0
	Moderate	6	8.0	3.5	2.0	13.5
	Poor	3	8.0	4.5	2.0	14.5

**See chapter 3 for traffic and soil class details*

Arterial Streets

Arterial streets provide the highest operating speeds and the highest levels of traffic service. They serve the major corridors of traffic and are usually multiple lane in urban areas. They are typically high-volume facilities that connect major activity centers.



As with the design of residential and collector facilities, many localities have adopted standards for the design and construction of arterials. All applicable local and state codes, standards, and specifications should be complied with when designing and constructing these facilities. The information contained in this Design Guide should augment local guidelines in assuring the proper planning and design of arterials.

Although arterials frequently carry very large traffic volumes and heavy truck traffic, pavement designs recommended herein are applicable only to facilities having a low percentage of truck traffic. Design of Asphalt Concrete pavements for trucking highways requires considerable expertise and detailed analysis.

Table 4-3. Thickness Design: Arterial Streets

Design Criteria*			Thickness in Inches Asphalt Concrete		
Traffic Class (ADT)	Subgrade Class	CBR	Base	Surface	Total
IV (1,501-4,500 ADT)	Good	9	5.5	2.0	7.5
	Moderate	6	6.5	2.0	8.5
	Poor	3	7.5	2.0	9.5
V (6,001-9,500 ADT)	Good	9	7.5	2.5	10.0
	Moderate	6	8.0	3.0	11.0
	Poor	3	9.0	3.0	12.0
VI (9,501 & Above ADT)	Good	9	Special design consideration needed. Refer to a more complete design procedure.		
	Moderate	6			
	Poor	3			

**See chapter 3 for traffic and soil class details*

Low-Volume Secondary and Rural Roads

Low-volume rural roads consist of local roads and collectors whose primary function is to provide access to abutting property and from there to arterial routes. Motorists' speeds may be low, or higher depending on the standards to which the specific facility is designed.

Truck traffic is usually low, consisting of some bus traffic and heavy trucks. Most traffic consists of vehicles providing local service such as heating oil and gasoline, local farm traffic, and farm vehicles.

Table 4-4. Thickness Design: Low Volume Secondary and Rural Roads

A. For Asphalt Concrete Base Pavements

Design Criteria*			Thickness in Inches Asphalt Concrete		
Traffic Class (ADT)	Subgrade Class	CBR	Base	Surface	Total
II (50-200 ADT)	Good	9	4.0	1.0	5.0
	Moderate	6	5.0	1.0	6.0
	Poor	3	5.5	1.5	7.0
III (201-700 ADT)	Good	9	4.0	1.5	5.5
	Moderate	6	5.0	1.5	6.5
	Poor	3	6.0	1.5	7.5
IV (1,501-4,500 ADT)	Good	9	5.5	2.0	7.5
	Moderate	6	6.5	2.0	8.5
	Poor	3	7.5	2.0	9.5

B. For Untreated Aggregate Base Pavements

Design Criteria*			Thickness in Inches			
Traffic Class (ADT)	Subgrade Class	CBR	Untreated Aggregate Base	Asphalt Concrete Base	Asphalt Concrete Surface	Total
II (50-200 ADT)	Good	9	5.0	.0	3.0	8.0
	Moderate	6	8.0	.0	3.0	11.0
	Poor	3	8.0	2.0	2.0	12.0
III (201-700 ADT)	Good	9	7.0	.0	3.0	10.0
	Moderate	6	8.0	2.0	2.0	12.0
	Poor	3	8.0	3.0	2.0	13.0
IV (1,500-4,500 ADT)	Good	9	8.0	3.0	2.0	13.0
	Moderate	6	8.0	3.5	2.0	13.5
	Poor	3	8.0	4.5	2.0	14.5

**See chapter 3 for traffic and soil class details*

High-Volume Secondary and Rural Roads

High-volume rural roads consist of arterial roads and the highway system. They provide the highest operation speeds and highest level of traffic service. These roads serve as the major corridors of traffic and frequently have multiple lanes.

These roads frequently carry large traffic volumes and heavy truck traffic. The information contained within this guide should augment local guidelines in assuring proper planning and design of high-volume roads. The values found here are only applicable to low truck volumes. Design of Asphalt Concrete pavements for trucking highways requires considerable expertise and detailed analysis.

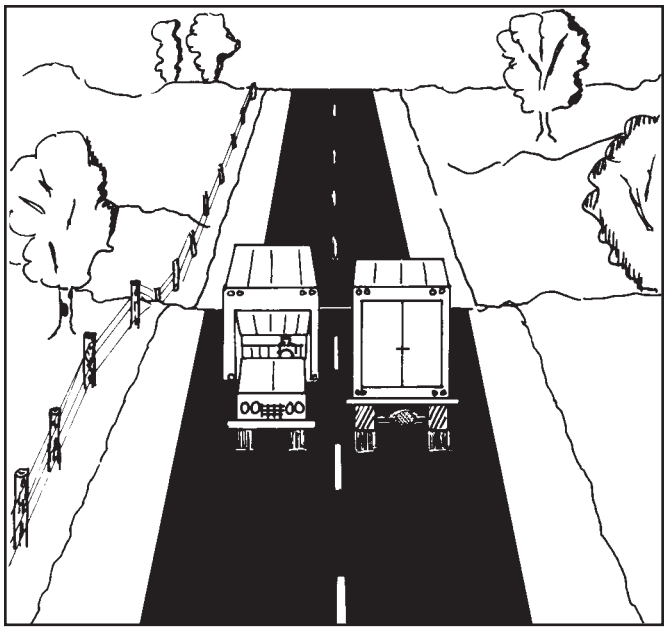


Table 4-5. Thickness Design: High Volume Secondary and Rural Roads

Design Criteria*			Thickness in Inches Asphalt Concrete		
Traffic Class (ADT)	Subgrade Class	CBR	Base	Surface	Total
III (201-700 ADT)	Good	9	4.0	1.5	5.5
	Moderate	6	5.0	1.5	6.5
	Poor	3	6.0	1.5	7.5
IV (1,501-4,500 ADT)	Good	9	5.5	2.0	7.5
	Moderate	6	6.5	2.0	8.5
	Poor	3	7.5	2.0	9.5
V (6,001-9,500 ADT)	Good	9	7.5	2.5	10.0
	Moderate	6	8.0	3.0	11.0
	Poor	3	9.0	3.0	12.0
VI (9,501 & Above ADT)	Good	9	Special design consideration needed. Refer to a more complete design procedure.		
	Moderate	6			
	Poor	3			

**See chapter 3 for traffic and soil class details*