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Virginia Department of Transportation

Pavement Design Guide for Subdivision and Secondary Roads in Virginia

A companion reference to the Secondary Street Acceptance Requirements

Prepared by

Materials Division
and
Virginia Transportation Research Council

VDOT Virginia Department of Transportation

First Printing ~ October 1973
Revised March 1993
Revised January1996
Revised August 2000
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DISCLAIMER

AND

PRECEDENCE OF LOCAL JURISDICTION ORDINANCES

This guide is intended to aid professional personnel knowledgeable in the field of pavement design. Persons using this guide are responsible for its proper use and application. The Virginia Department of Transportation and individuals associated with the development of this material cannot be held responsible for improper use or application.

The design procedures presented in this guide are primarily for flexible pavement to establish minimum structural requirements. However, acceptable methods are referenced for the design of rigid pavement. Where the subdivision ordinance of a locality has established a pavement design requirement that exceeds the pavement design obtained by these procedures, then that design process shall govern. However, these procedures shall govern the design of pavements for roadways under Department jurisdiction. For pavements not under the Department's jurisdiction, the respective locality may choose to use alternative pavement design procedures including but not limited to locality's own method, AASHTO 1993, Darwin, PaveXpress, Winpas, Streetpave, pavementdesigner.org etc. This is for information purpose only and does not reflect any endorsement of whatsoever from VDOT regarding the noted designs.

BACKGROUND

This revision provides the following major items:

1. Reference to recycled materials and process.
2. Reference to provision allowing the use of Mechanistic Empirical Pavement Design Guide (MEPDG) for certain high volume secondary routes

This version replaces earlier documents designated VHRC 73-R18, VHRC 73-R21, 1993, 1996, 2000, 2009 and 2014 for "Pavement Design Guide for Subdivision and Secondary Roads in Virginia" respectively.

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Introduction

This guide presents structural design methods for both flexible and rigid pavements intended for new subdivision streets and secondary roads.

The flexible pavement design method presented in this guide was developed by Dr. N. K. Vaswani, who based it on the original AASHO Road Test Results of 1962 and reflects Virginia's design experience.

The rigid pavement design method in this guide utilizes AASHTO 93 “Guide for Design of Pavement Structures”.

Two design approaches are included in this guide:

A. Conventional Pavement Design Method, which requires a rigorous pavement design procedure.

   The conventional flexible pavement design procedure may be divided into two parts:

   1. The evaluation of design variables:
      a. the traffic in terms of projected Annual Average Daily Traffic (AADT)
      b. the soil support value of the subgrade.
   2. Design considerations:
      a. determination of the required Thickness Index of the pavement
      b. the selection of paving materials based on the sum of the products of their thickness and thickness equivalencies equaling or exceeding the required Thickness Index value.

B. Alternate Pavement Design Method, which allows the use of predetermined pavement structural designs for qualifying new subdivision streets.

Specifications And Additional Resources

Specifications for all materials, testing, construction, and installation can be found in the following Virginia Department of Transportation documents:

- Road and Bridge Specifications and appropriate supplemental specifications
- Virginia Test Methods Manual
- Road and Bridge Standards.

Traffic information for existing VDOT maintained roadways can be obtained at the following internet link - http://www.virginiadot.org/info/ct-TrafficCounts.asp

- **Computer Software**

Computer software developed by VDOT can be used for Subdivision and Secondary Roads pavement design. It is available through the following link ”http://www.virginiadot.org/business/materials-download-docs.asp” or by contacting the District Materials Engineers.

- **Metric Conversions**

The following metric conversion factors shall be used throughout this document.

1 inch = 25 mm	1 pound mass = 454 grams
1 foot = 300 mm	1 pound force = 4.448 Newton
1 mile = 1.6 km	1 pound/in sq. = 6.895 Pascal

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Discussion of Design Variables

Projected Traffic in Terms of Annual Average Daily Traffic (AADT)

The method used to determine the Design AADT varies based on the project considered. Essentially, the methods are as follows:

A. New Subdivision Streets

The traffic volume for subdivision streets shall be developed as specified in Appendix B (1) of the Department's Road Design Manual as referenced by the Secondary Street Acceptance Requirements (SSAR). The traffic is subject to further adjustment as outlined in the "Flexible Pavement Design Worksheet for New Subdivision Streets" of Appendix IV of this pavement design guide.

B. Secondary Roads

Pavement design for existing Secondary Roads shall be based on the projected traffic volume for the midpoint of the 20 year design period (i.e. 10 years) after completion of roadway construction. A more complete discussion regarding this factor is found under the section "Design Procedures."

Soil Support Value (SSV) of the Roadway Subgrade Soil

The Soil Support Value of the subgrade soil is the product of the Design CBR and the soil Resiliency Factor for the soil encountered, as expressed in Equation 1. SSV is used in conjunction with the design traffic volume (Design AADT) to determine the minimum structure requirement (Required Thickness Index) for the pavement.

SSV = Design CBR x RF **Equation 1**

Note: Subgrade soils that are very weak or have a very low resiliency factor (i.e. SSV ≤ 2) should be stabilized or under cut.

A. **California Bearing Ratio (CBR) of the Roadway Subgrade Soil**

The California Bearing Ratio (CBR) is the ratio of the resistance to penetration exhibited by a subgrade soil to that exhibited by a specimen of standard crushed stone base material. The resistance of the crushed stone under standardized conditions is well established. The objective of a CBR test is to determine the relative resistance of the subgrade material under the same conditions.

The CBR of the subgrade soils is the principle component of the soil support value (SSV) used in flexible pavement design to determine the required pavement thickness index.

1. Test Method

All CBR values are to be determined in accordance with "The Virginia Test Method for Conducting California Bearing Ratio Tests" (Designation VTM-8). For each roadway, a sufficient number of CBR tests must be conducted to determine the average CBR value for the various soil types anticipated to be in the subgrade.

2. **Soil Sampling**

Representative soil samples for CBR tests shall be taken from the top 12 inches of the proposed grade by a qualified soils technician or engineer. If the subgrade soil has been identified as fine grained (i.e. more than 35% passing the 200 sieve according to AASHTO Classification System), Atterberg tests (Liquid and Plastic limits) shall be run in addition to the normal sieve analysis, laboratory compaction and CBR tests, so that an assessment of the potential need for subgrade stabilization or undercut can be made. If indications of unstable conditions for construction equipment are present, natural moisture content determinations should also be made to aid in determining the appropriate method of stabilization/undercut by comparison with the Atterberg Limits of the soils.

a. Soil Sample Frequency and CBR Tests for Design of New Subdivision Streets

1) For streets less than 200 feet in length, one soil sample for conducting AASHTO (AASHTO M 145) and Unified (ASTM D 2488) soil classifications and CBR test is required.

2) For streets 200 to 500 feet in length, at least two soil samples for conducting AASHTO and Unified soil classifications and CBR tests is required, which includes one at each intersection with an existing state road.

3) For longer streets, one soil sample shall be taken at each intersection with an existing state road plus one test sample every 500 feet in length, or portion thereof, is required for conducting AASHTO and Unified soil classifications and CBR tests.

b. Soil Sample Frequency and CBR Tests for Design of Secondary Road Projects

The District Materials Engineer should assure that sufficient CBR tests are made to represent the various soils encountered on the project. This is to assure that a reasonable estimate of the average subgrade CBR is determined. The frequency of soil samples for secondary road projects will be determined by the District Materials Engineer under the general guidance of the Materials Division Manual of Instructions.

3. **Relationship of Design CBR to Number of Tests Performed**

Design CBR is a factor of the number of CBR test results available.

a. For five tests or less, the design CBR shall be the mathematical average of these tests multiplied by two-thirds, rejecting any obviously extreme value.

b. For more than five tests, the highest and lowest CBR values are rejected and the Design CBR value shall be the mathematical average of the remaining CBR test values multiplied by a factor of two-thirds.

The two-thirds factor provides the necessary safety margin to compensate for any non-uniformity of the soil, and for any low test results not considered when computing the average of the CBR sample values.

Furthermore, four days of soaking, as specified in the CBR test method, does not necessarily give the minimum CBR strength of some soils. Thus, the two-thirds factor would compensate for all such variations.

4. **Construction Factors**

The design CBR determination process assumes that the properly compacted subgrade soil will produce a stable platform for pavement construction. If an unstable subgrade is encountered, it should be stabilized or undercut to a firm foundation. Stabilization would use lime or cement (depending on PI of the soil). Undercut material would be replaced with adequately compacted soil or aggregate materials. The use of a geosynthetic to produce a stable platform for construction equipment is acceptable.

Subgrade compaction should be verified every 1000 feet before placement of the subbase/base layer, with a minimum of two compaction tests per roadway. The compaction shall be 100 percent of standard proctor (VTM-1) for all but gravely soils. Refer to Section 305.03 of The Road and Bridge Specification for compaction requirements for gravely soils.

B**.** **Resiliency Factor (RF)**

1. When soil is repeatedly loaded, it undergoes both recoverable (elastic) and permanent (plastic) deformation. The Resiliency Factor is a relative value that reflects a soil's elastic deformation characteristics and its ability to withstand repeated loading.

2. The smaller the elastic deformation the higher the degree of resiliency, and the better the subgrade support. The subgrade soils in Virginia are divided into five load support characteristics based on their degree of resiliency (see Table 1). The resiliency factor of a given soil can be obtained most precisely if the soil classification is known.

   Predicted regional resiliency factors are shown in Appendix I. These factors are valid only when the in-situ moisture content of the subgrade soil is at or near optimum moisture content.

   The optimum moisture content is determined by AASHTO Test Method T 99, Method A, as modified by VTM-1. Additional moisture content testing should be conducted during construction if visual observations dictate. Soils with a moisture content of 20 percent above optimum may need special treatment or may need to be undercut and replaced.

3. Evaluation of Soil Resiliency Factors

   Three primary factors are considered in the evaluation of Soil Resiliency Factors:

   a. Soil Classification (based on AASHTO M- 145)

   b. Sand content (percent retained on No. 200 sieve)

   c. Mica content

Determination of the mica content is to be done by visual observations. Borderline cases of low or high mica content shall be decided by the District Materials Engineer of the Virginia Department of Transportation.

Use Table 1 to determine the soil resiliency factor, proceeding from the top to the bottom and obtain the correct resiliency factor by the process of elimination.

Table 1
Classification, Load Support Characteristic, and Resiliency Factor
of
Common Soils in Virginia

Mica Content	Soil Classification	Load Support Characteristic	Resiliency Factor
Without Mica	a) A-1 & A-3 Soils b) A-4, A-5 and A-7 soils having a sand content greater than 60%	Excellent	3.0
	A-2, A-4, A-5, A-6 and A-7 soils having a sand content between 40% and 60%.	Good	2.5
	A-2, A-4, A-5, A-6 and A-7 soils having a sand content less than 40%	Average	2.0
With Mica	a) A-7-5 soil. b) soil with low or trace mica content and having an average group index (GI) below 5 c) A-2, A-5, A-6, and A-7-6 soils with low or trace mica content	Poor	1.5
	Soils not within the category of Medium Low Resiliency Soils and also contain mica.	Very Poor	1.0

Discussion of the Flexible Pavement Design Method

Subdivision and Secondary roads in Virginia usually consist of two or three layers of different materials of varying depth over the subgrade. The two-and three-layer systems are shown in Figure 1.

Figure 1 - Illustration of 2 and 3 layer pavement systems.

2 Layer System		
Pavement Layer	Thickness (inches)	Thickness Equivalency
Surface	**h_1**	**a_1**
Base	**h_2**	**a_2**
Subgrade		

3 Layer System		
Pavement Layer	Thickness (inches)	Thickness Equivalency
Surface	**h_1**	**a_1**
Base	**h_2**	**a_2**
Subbase	**h_3**	**a_3**
Subgrade		

The soil support value (SSV) and the design traffic volume (Design AADT) are used with the nomograph (Appendix II) to determine the minimum structural requirement of the pavement, termed the Required Thickness Index, expressed as D_R. This minimum structure requirement is satisfied by providing materials of known strength indices, termed Thickness Equivalencies (a), sufficient thickness (h) to develop a Pavement Thickness Index (D_P), which will equal or exceed D_R. These variables are discussed in the following sections.

A. **Thickness Equivalency Value (a_x)**

The thickness equivalency value of a given material (a_x, where x is the identity of the pavement layer) is an empirical relationship between the Thickness Index (also known as Structural Number) and the thickness and it is a measure of the relative ability of the material to function as a structural component of the pavement. Its value depends on the type of the material and its location in the pavement structure. The thickness equivalency values of paving materials are shown in Appendix III.

The thickness equivalencies of some materials differ depending on their location in the pavement structure; higher when used in the base than when used in the subbase. For example, untreated crushed aggregate has a thickness equivalency value of 0.6 when used in the subbase course and 1.0 when used in the base course. Cement treated aggregate and select materials types I and II are considered similarly, see Appendix III.

Investigation and experience has shown that the strength of cement treated native soils or borrow materials (e.g., select materials type II and select borrow) vary depending upon their physical and chemical properties. For consistency and simplicity, the thickness equivalencies of such materials are assumed to be the same whether they are placed in the base or in the subbase.

In 2-layer pavement systems, if the thickness of the lower layer is 8 inches or less, the lower layer is designated the base layer. However, if the thickness is greater than 8 inches, that portion which exceeds 8 inches in thickness is considered a subbase layer and the pavement structure computed as a 3-layer system, with the subbase layer thickness being the thickness of the lower layer reduced by 8 inches.

Example: A 2-layer system having 12 inches of aggregate in the lower layer, the base is treated as 8 inches with an equivalency of 1.0 and a Subbase of 4 inches with an equivalency of 0.6
(i.e. h_2 = 8 inches, a_2 = 1.0 and h_3 = 4 inches, a_3 = 0.6).

The thickness equivalency values of new paving materials must be evaluated relative to established thickness equivalencies as each material is introduced.

B. **Thickness Index Value (D)**

The Thickness Index (D) represents the total structure of the pavement based on its resistance to a deflection caused by a wheel load. The minimum thickness index required, based on the SSV of the subgrade and design traffic volume (Design AADT) is denoted with the symbol D_R and is obtained from the nomograph (Appendix II). The thickness index value of a pavement design is denoted by the symbol D_P and is obtained by Equation 2 below. A potentially acceptable pavement design is derived when D_P equals or exceeds D_R (i.e. $D_P \geq D_R$).

$$D_P = a_1h_1 + a_2h_2 + a_3h_3 + \ldots + a_xh_x \qquad \textbf{Equation 2}$$

Where: a_1, a_2, and a_3 are the thickness equivalencies of the surface, base and subbase layers, and h_1, h_2, and h_3 represent the thickness in inches of the surface, base, and subbase layers, respectively. In the case of a two-layer system a subbase may not be provided; in this instance, $a_3h_3 = 0$.

Figure 2 - Illustration of a 3-layer pavement design using values from Appendix III in Equation 2.

Pavement Layer	Material	Thickness inches (h_x)	Thickness Equivalency Value (a_x)	(h_x) x (a_x)
Surface	**165 P/SY Asphalt Concrete SM-9.5A**	1.5	2.25 [1]	3.38
Base	**3" Asphalt Concrete BM-25.0A**	3.0	2.25	6.75
Subbase[2]	**Untreated Aggregate (21B)**	6.0	0.60	3.6
Subgrade		$D_P = a_1h_1 + a_2h_2 + a_3h_3 =$		13.73

1 Note: The higher thickness equivalency value is used for the surface and base material because the combined thickness of the asphalt concrete equals 4.5 inches. Refer to footnote, Appendix III

2 When untreated aggregate materials are used, the maximum combined thickness shall be 12 inches for the purpose of calculating the thickness index value.

Design Procedures

New subdivision street pavement designs are to be developed using the "Flexible Pavement Design Worksheet for New Subdivision Streets" (Appendix IV), which the developer shall submit with the design documents for each new subdivision street. Certain new subdivision streets (with a low traffic volume) may qualify to use the Alternate Pavement Design Method.

Pavement designs for secondary road projects, including developer projects augmenting, realigning, or relocating secondary roads, are to be developed using the Conventional Pavement Design Method.

Conventional Pavement Design Method

A. **Determination of Design Traffic (Design AADT)**

The Design AADT used to determine D_R from the nomograph in Appendix II, assumes the traffic volume is equally distributed in both directions. In addition the lane distribution shall be considered as follows:

a. For all new subdivision streets and two-lane secondary road facilities (one lane in each direction), including the initial two lane phase of a four lane facility when that phase is expected to sustain two-way traffic for an appreciable length of time; the Design AADT shall be the full traffic volume of the roadway.

b. The Design AADT for multi lane facilities, except as restricted in paragraph a, shall be 80% of the full roadway traffic volume for 4-lanes (two lanes in each direction) and 70% for 6-lane facilities.

1. For traffic volumes exceeding 10,000 AADT, the actual truck count and classification needs to be determined and the pavement designed as a primary road facility rather than as a secondary road or new subdivision street using the Mechanistic Empirical Pavement Design procedure (MEPDG) in conjunction with the Department's Materials Division Manual of Instruction Chapter VI, unless otherwise approved by the District Materials Engineer. If truck classification is not available for the section, the statewide average given in VDOT MEPDG user manual should be used. **Design AADT for New Subdivision Streets**

Design AADT for new subdivision streets shall be determined as described in the current edition of Appendix B (1) of the Department's Road Design Manual, subject to any adjustment as may be indicated in Step 1 of the "Flexible Pavement Design Worksheet for New Subdivision Streets" (Appendix IV) and as further explained in paragraph 3, "Design AADT When Percent Heavy Commercial Vehicles (%HCV) Exceeds 5.0%." Therein, the term 'present traffic' shall be synonymous with the term 'projected traffic' when new subdivision streets are considered.

2. **Design AADT for Secondary Roads**

The Design AADT for an improvement to the secondary roads system shall be determined by Equation 3:

Design AADT $_{(n)}$ = Present AADT x [1 +(GR.)]^n Equation 3

Where: Design AADT is the Annual Average Daily Traffic volume projected for the design year (typically the 10th year after construction is complete) and "n" is the number of years between the design year and the year of the present traffic volume (AADT).

The Present AADT is the current traffic volume (AADT) in both directions, determined from an actual traffic count or from preliminary engineering estimates, provided/approved by VDOT's Traffic Engineering or Transportation Planning Divisions.

GR. is the Growth Rate percentage expressed as a decimal (i.e. 5% GR. = 0.05), which may be based on actual historical traffic data or from estimates made by Traffic Engineering Division. The expression [1 + (GR.)]^n yields the "Growth Factor" based on the anticipated annual rate of growth of traffic.

Example: If the Present AADT = 700 for Year 2009, the GR. = 3.6%, and the Roadway Construction is to be completed in Year 2012.

Then: 10th Year after Construction = 2012 + 10 = 2022;

Thus, n = 2022 - 2009 = 13 and Equation 3 yields:

Design AADT$_{13}$= 700 x [1 + (0.036)]^{13} = 700 x (1.036)^{13}
= 700 x (1.584) = 1109 AADT in Year 2022

3. **Design AADT When Percent Heavy Commercial Vehicles (%HCV) Exceeds 5.0%**

The nomograph in Appendix II assumes the number of Heavy Commercial Vehicles (HCV), defined as trucks, buses, etc., having 2 or more axles and 6 or more tires, does not exceed 5.0% of the total traffic volume (AADT). When the design traffic volume includes more than 5.0% HCV, each heavy commercial vehicle above the 5.0% level is considered equal to twenty (20) typical (i.e. non-HCV) vehicles. An Equivalent Present Traffic volume (EPT) representing this adjustment is calculated by Equation 4, the results of which are to be substituted for the Present AADT value used in Equation 3.

EPT = Pres. AADT + (20 x Number of HCV over 5.0%) Equation 4

{Note: Number of HCVs over 5.0% = (% HCV - 5.0%) x Present AADT, where (% HCV - 5.0%) is expressed as a decimal}

Example: If Present Traffic Volume = 1000 AADT, Percent Trucks = 8 %
Using Equation 4:
EPT = 1000 + {20 x [1000 x (0.08-0.05)]}
= 1000 + [20 x (1000 x 0.03)]
= 1000 + (20 x 30)
= 1000 + 600 = 1600 AADT

B. Determination of Design CBR, Resiliency Factor (RF), and Soil Support Value (SSV)

1. The Design CBR, as discussed earlier, is the product of the average values of the CBR test results and a safety factor of 2/3, expressed as Equation 5.

Design CBR = Average CBR x 2/3 Equation 5

2. Determination of Resiliency Factor (RF)

   The Resiliency Factor (RF) may be determined by one of the following methods:

   a. Table 1
   b. Appendix I - Predicted Regional Resiliency Factors, which are shown graphically for the state and in a listing by county. These values are to be considered maximum values unless otherwise approved by the District Materials Engineer.
   c. Obtained from the District Materials Engineer.

3. Determination of Soil Support Value (SSV)

   The Soil Support Value (SSV) is the product of the Design CBR and RF, as expressed in Equation 1 (SSV = Design CBR x RF), and has a maximum value of 30.

4. Preliminary pavement designs may use the predicted SSV values from Appendix I. However, when the soil moisture content exceeds the plastic limit, and approaches the liquid limit, the predicted values in Appendix I should not be used and a maximum SSV of 2 should be used. Pavement designs for new subdivision streets shall be considered preliminary designs, **not approved for construction**, until substantiated by acceptable test results of the subgrade soil. Approval of the final design shall be obtained prior to construction of the pavement.

5. Even if lime or cement stabilization of the roadway subgrade is to be considered, the Soil Support Value is based on tests of the non-stabilized soils. Only in the rare case where multiple layers are stabilized for a total stabilized depth of 2 feet or more may the SSV be based on tests of the stabilized soil.

6. Where undercutting and backfilling with dense graded aggregate material or unusually high CBR native soil material is necessary to provide a stable construction platform, the Soil Support Value is still to be based on the native soil test results. The only exception to this would be if the entire roadway subgrade is undercut and backfilled to a minimum depth of 2 feet.

C. Determination of Required Thickness Index (D_R)

The required thickness index (D_R) is determined from the nomograph in Appendix II, by projecting a straight line from the Soil Support Value (SSV), through the Design AADT value, to intersect the Required Thickness Index scale, from which the minimum required Thickness Index (D_R) is read. Alternately, computer software developed by VDOT can be used for pavement design. It is available through the following link "http://www.virginiadot.org/business/materials-download-docs.asp" or by contacting the District Materials Engineers.

D. **Choice of Materials and Pavement Layer Thickness**

After D_R is determined, the pavement structure design can be derived, as earlier discussed and illustrated in Figure 2, subject to the factors discussed in the sections "Design Considerations" and "Drainage Considerations for Flexible and Rigid Pavements."

Alternate Pavement Design Method

Acceptable, flexible pavement designs for low traffic volume (Design AADT ≤ 400) new subdivision streets are shown in Appendix IV (Tables A and B). These predetermined pavement designs may only be used in conjunction with the "Flexible Pavement Design Worksheet for New Subdivision Streets" (Step 3A) provided in Appendix IV. Acceptable rigid pavement designs for low volume (Design AADT ≤ 400) new subdivisions are presented on page 16.

For new subdivision streets and secondary road projects having a Design AADT greater than 400, pavement designs must be determined using the Conventional Pavement Design Method, which is accommodated in Step 3B of the "Flexible Pavement Design Worksheet for New Subdivision Streets."

DESIGN CONSIDERATIONS

After the Required Thickness Index (D_R) of the pavement has been determined, the choice of materials and the thickness of the layers for the pavement design are primarily at the discretion of the pavement designer. These decisions are usually based on dollar value, structural adequacy, pavement serviceability, historical data, experience, availability of materials, ease of construction, maintenance of traffic, etc.

A. Practical Consideration for Thickness of Layers

The thickness of layers is related to practical considerations. The following are some of the physical characteristics of materials to be considered:

1. The maximum obtainable density of aggregates and asphalt concretes.
2. The stability of asphalt concrete mixes.
3. The preparation of the subgrade (by providing a stabilized subgrade layer).
4. The weakness of thin layers of fairly rigid materials like asphalt concrete, and stabilized soil layers.
5. Nominal aggregate size of the asphalt mix.

B. Recommended Minimum and Maximum Limits

The recommended minimum and maximum limits for the thickness of pavement layers are shown in Appendix III, however, not less than 4.5 inches of asphalt concrete must be placed over cement treated base/subbase material (CTA) as the surface/intermediate/base layer(s). In addition, the following criteria shall be considered:

1. Maximum thickness of an asphalt concrete surface shall be 2 inches, except as follows:
   a. When staged surfacing is required, a maximum of 2½ inches of surface is allowable, provided the thickness of the final layer is not less than one inch and at least one year’s time elapses between the placement of the initial and final surfaces.
   b. A maximum thickness of 3 inches is allowable when using Type IM-19.0A.
   c. Six inches of full-depth asphalt concrete pavement is the minimum recommended allowable thickness (surface mix and base mix) when placed directly on the prepared subgrade, except as may be permitted by Tables A and B in Appendix IV for qualifying new subdivision streets.
2. The maximum thickness of aggregate material used as the base layer shall be 8 inches before considering any additional thickness as a subbase material.
3. Maximum combined thickness of the base and subbase aggregate layers is 12 inches.

General Notes and Specifications

All full lane widening projects and turn-lane additions shall be in accordance with VDOT WP-2 standard

The following recommendations are based on the Department's design and construction experience:

A. Subgrade, Subgrade Treatment, or Subbase

1. The preparation of the subgrade should be in accordance with the current Virginia Department of Transportation's Road and Bridge Specifications.
2. Local materials, free of organic matter that normally would be considered unsatisfactory for use in construction, may be acceptable when stabilized with a stabilizing agent, such as cement or lime. Lime or cement stabilized subgrades provide a sound foundation that is a good investment when the traffic is likely to increase considerably. Additionally, this practice may prove to be the most economical.
3. For soils having a high moisture content, treatment with lime or other pozzolanic material (1% to 2% by weight), in lieu of undercutting, may be appropriate. However, such lime treatment is not to be considered part of the pavement structure in calculating the Thickness Index.
4. When cement stabilized subgrade is recommended, approximately 10% by volume should be used. When lime is the subgrade stabilizing agent, approximately 5% by weight should be used. If Select Material, Type II is used, cement stabilization is required. In all cases, representative samples of the soil should be tested in accordance with VTM-72 (for Cement) and VTM-11 (for Lime) to determine the optimal percentage. If soil stabilization (cement or lime) is used, verification of the quantity of stabilizing agent actually used will be required through the District Materials Engineer.
5. When cement stabilized aggregate is used over very weak soils (SSV ≤ 2), it should be placed over a minimum of 4 inches of untreated aggregate.
6. Soil stabilization should be completed before the ambient air temperature drops below 40 degrees Fahrenheit and, for best results, covered immediately with an untreated aggregate course (provided that construction equipment does not damage the stabilized course) or an asphalt seal.
7. Geosynthetics may be considered for subgrade stabilization, when the areas in question represent a relatively small amount of the subgrade soils. This may prove more economically feasible, in isolated cases, than the Alternates discussed above. Refer to VDOT Road & Bridge Specifications regarding geosynthetics for subgrade stabilization to select the proper strength requirements.

B. Aggregate Courses

1. Aggregate Base Materials are of two types and various sizes as shown below:
   a. Type I - Aggregate base material (crushed material only) using size No. 21A, No. 21B or No. 22 aggregate. The coarser graded aggregate Size No. 21 B is preferred for AADT over 1000.
   b. Type II Aggregate base material (crushed or uncrushed material) using No. 21A, or No. 22 size aggregate.

2. All untreated aggregate used in base or subbase courses shall be No. 21B gradation, except on roads with an ADT of 1000 or less; where No. 21A or No. 21B may be used. When the No. 21B gradation is used, drainage concerns must be addressed. Use No. 21A gradation if the aggregate is cement stabilized (i.e. CTA).

3. When a local aggregate material is stabilized with cement, approximately 8% by volume should be used. When lime is used as the stabilizing agent, approximately 4% by weight should be used.

   In all cases, however, representative samples of the material should be tested to determine the correct percentage of stabilizing agent. A minimum stabilized depth of 6 inches is required.

4. When cement treated aggregate (CTA) is proposed for use a minimum of 4.5 inches of asphalt concrete should be used atop the CTA in order to retard reflection of the shrinkage cracks from the CTA.

C. Surface Course

An asphalt concrete surface course of 220 pounds per square yard (2 inches thick), may be used in lieu of a Class "C" or Class "D" blotted seal or a prime and double seal surface treatment (as specified in all current L&D I&I memoranda).

D. Minimum Designs (Limited to Secondary Road Improvement Projects with AADT ≤ 50)

1. The base should consist of a minimum of 6 inches aggregate base material, Types I or II, yielding a thickness index of 6.

2. The following minimum recommended design shall only be used when the road is to be surface treated.

   As an Alternate, in areas containing borderline local materials but not meeting the specifications for Type I or II base materials, the base may consist of a minimum depth of 6 inches of select borrow having a minimum CBR value of 20. The select borrow base should be stabilized with cement, 8% to 10% by volume, or approximately 40 pounds of cement per square yard. The cement stabilized borrow should be surfaced with a curing agent and double seal. In all cases, however, representative samples of the material should be tested to determine the correct percentage of stabilizing agent.

DESIGN METHODS FOR RIGID PAVEMENT

Conventional Rigid Pavement Design

The following rigid pavement design method is acceptable: 1993 AASHTO Guide for Design of Pavement Structures using a minimum of 5% truck traffic or the actual truck traffic (whichever is higher). The thickness shall be rounded up to the nearest 0.5 inches. Concrete shall be Class A-3 paving concrete according to the current Virginia Department of Transportation’s Road and Bridge Specifications and appropriate supplemental specifications. The pavement shall be Plain Jointed Portland Cement Concrete with a designed transverse joint spacing not to exceed 15 feet (the joint spacing in feet shall not exceed 2 times the pavement thickness in inches). Non dowelled pavement 6” or less in thickness, shall have at least 3 longitudinal joints (no joint along the wheel path), shall have maximum aspect ratio of 1:1 (length to width) and shall have maximum panel size of 8 feet by 8 feet. Some typical joint detail examples are provided in Append VI. Continuously Reinforced Concrete Pavement may be considered an acceptable option. In the case of very weak or very low resiliency soils having CBR values less than 2, the soil should be stabilized for a depth of six (6) inches with cement, 10% - 12% by volume, or in accordance with a detailed geotechnical design which the developer shall submit with the design documents for each new subdivision street.

For traffic volumes exceeding 10,000 AADT, the actual truck count and classification needs to be determined and the pavement designed as a primary road facility rather than as a secondary road or new subdivision street using the Mechanistic Empirical Pavement Design Guide (MEPDG) in conjunction with the Department's Materials Division Manual of Instruction Chapter VI, unless otherwise approved by the District Materials Engineer. If truck classification is not available for the section, the statewide average given in VDOT MEPDG user manual should be used.

Alternate Rigid Pavement Design

In lieu of using the design methods above, an alternate pavement design for low traffic volumes (Design AADT 400 or less) for subdivision streets is provided in Table 2. Table 2 is applicable only when Soil Support Value (SSV) ≥ 10, minimum concrete flexural strength of 650 psi (28 day) and concrete curb and gutter or shoulders are used. If all of the above conditions are not met and/or the developer does not want to use catalog section, the pavement shall be designed using Conventional Rigid Pavement Design by a professional engineer licensed in Commonwealth of Virginia and submit the design to VDOT for review and approval.

Table 2
Alternate Rigid Pavement Design

Design AADT	Minimum Slab Thickness	Minimum Aggregate Thickness	Maximum Transverse Joint Spacing
0-400	5 inches	6 inches	8 feet

Slab:
A Minimum thickness of 5 inches non doweled, jointed plain concrete pavement shall be used.

Materials:
Class A-3 concrete shall be used.

Base:
A minimum of 6 inches aggregate base (21B) shall be used.

Joints:
The subdivision street shall use minimum three (3) longitudinal joints within the road width. Longitudinal joints shall not be located in the wheel path. Joints will be sealed using hot pour asphalt or other approved joint sealant materials.

Paneling:
Panels will be created using an aspect ratio of 1:1. The maximum panel size shall be 8 feet by 8feet.

DRAINAGE CONSIDERATIONS FOR FLEXIBLE AND RIGID PAVEMENTS

The presence of water within the pavement structure has a detrimental effect on pavement performance under anticipated traffic loads. The following are guidelines to minimize these effects:

a) Standard UD-2 underdrains and outlets are required under all raised grass medians to prevent water infiltration through or under the pavement structure. Refer to the current VDOT Road and Bridge Standards for installation details.

b) When Aggregate Base Material, Type I, Size No. 21B is used as an untreated aggregate base or subbase, it shall be connected to a longitudinal pavement edge drain (UD-4) with outlets to provide for positive lateral drainage on all roadways with a design AADT of 1,000 vehicles per day or greater. (Refer to the current VDOT Road and Bridge Standards for installation details). The District Materials Engineers may waive the requirement for UD-4 installation in special instances, providing another means of pavement drainage such as cross drains or “daylighting” of the subbase course is used. Other drainage layers can also be used.

c) Undercutting, transverse drains, stabilization, and special design surface and subsurface drainage installations should be considered whenever necessary to minimize the adverse impacts of subsurface water on the stability and strength of the pavement structure.

d) Standard CD-1 and CD-2 for cut to fill and vertical sags respectively should be considered for use with all types of unstabilized aggregates.

e) For roadways with a design AADT of 20,000 vehicles per day or greater, an Open Graded Drainage Layer (OGDL) need to be considered, and when used it shall be placed on not less than 6-inches of stabilized material and connected to a UD-4 edge drain system.

f) Where cement treated aggregate (CTA) is the only aggregate used in a pavement structure, UD-4 pavement edge drains are not normally required.

For additional information see Report Number FHWA-TS-80-224, Highway Sub-drainage Design from the US Department of Transportation, Federal Highway Administration.

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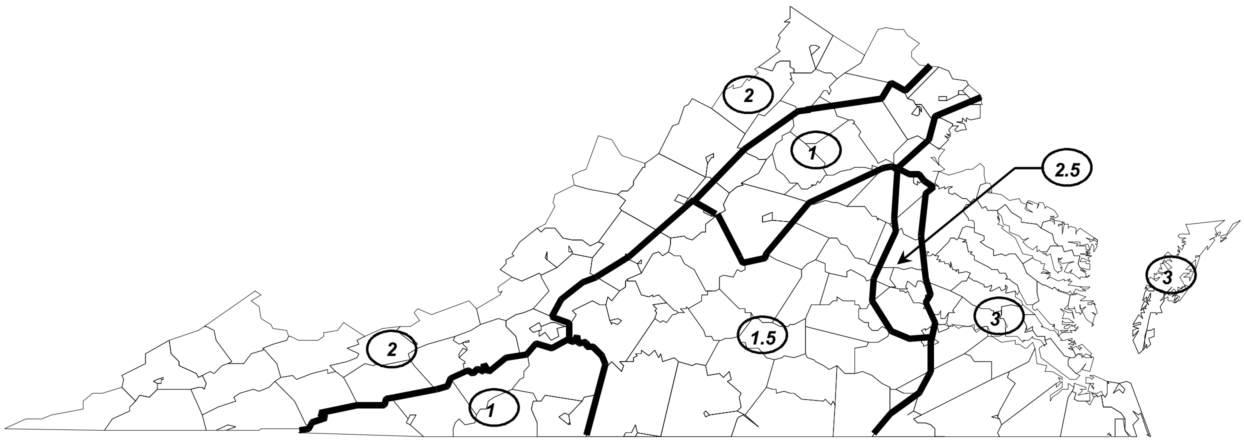
APPENDIX I
Predicted Resiliency Factors, CBR and Soil Support Values

Values may be used for preliminary pavement design only. Final designs must be based on soil tests.

NOTE

Appendix I shall not be used and SSV shall not exceed a value of 2 when the moisture content of the soil exceeds the plastic limit, approaching the liquid limit (e.g. high water table or other reasons).



Regional Chart of Soil Resiliency Factors

Table of Values by County

County Code	County		RF	CBR	SSV
00	Arlington	W. of Rte. 95	1.0	7	7
		E. of Rte. 95	3.0	10	30
01	Accomack		3.0	7	21
02	Albemarle	E. of Rte. 29	1.0	4	4
		W. of Rte. 29	1.0	5	5
03	Alleghany		2.0	5	10
04	Amelia		1.5	6	9
05	Amherst		1.5	5	7.5
06	Appomattox		1.5	5	7.5
07	Augusta		2.0	6	12
08	Bath		2.0	5	10
09	Bedford		1.5	5	7.5
10	Bland		2.0	6	12
11	Botetourt	From the western base of the Blue Ridge Mountains to the east	1.5	4	6
		Remainder of county	2.0	4	8
12	Brunswick		1.5	7	10.5

APPENDIX I continued

Table of Values by County					
County Code	County		RF	CBR	SSV
13	Buchanan		2.0	6	12
14	Buckingham		1.5	5	7.5
15	Campbell		1.5	5	7.5
16	Caroline	W. of Rte. 2	2.5	10	25
		E. of Rte. 2	3.0	10	30
17	Carroll		1.0	8	8
18	Charles City		3.0	10	30
19	Charlotte		1.5	5	7.5
* 131	Chesapeake		3.0	6	18
20	Chesterfield	SW of a line from Mosley to Colonial Heights	1.5	6	9
		Remainder of County	2.5	9	22.5
21	Clarke		2.0	6	12
22	Craig		2.0	4	8
23	Culpeper	E. of Rtes. 229 and 15S	1.0	4	4
		W. of Rtes. 229 and 15S	1.0	5	5
24	Cumberland		1.5	6	9
25	Dickenson		2.0	6	12
26	Dinwiddie		1.5	6	9
28	Essex		3.0	10	30
29	Fairfax	E. of Rte. 95	3.0	7	21
		W. of Rte. 95	1.0	4	4
30	Fauquier	N. of Rte. 211	2.0	4	8
		S. of Rte. 211	1.0	4	4
31	Floyd		1.0	8	8
32	Fluvanna		1.5	4	6
33	Franklin		1.0	8	8
34	Frederick		2.0	6	12
35	Giles		2.0	7	14
36	Gloucester		3.0	10	30
37	Goochland	W. of Rte. 522	1.5	7	10.5
		E. of Rte. 522	2.5	7	17.5
38	Grayson		1.0	5	5

APPENDIX I continued

Table of Values by County					
County Code	**County**		**RF**	**CBR**	**SSV**
39	Greene		1.0	5	5
40	Greensville	E. of Rte. 95	3.0	9	27
		W. of Rte. 95	1.5	9	13.5
41	Halifax		1.5	8	12
* 114	Hampton		3.0	9	27
42	Hanover	E. of Rte. 95	3.0	10	30
		W. of Rte. 95 and E. of Rte. 715	2.5	6	15
		W. of Rte. 715	1.5	6	9
43	Henrico	W. of Rte. 95	2.5	7	17.5
		E. of Rte. 95	3.0	7	21
44	Henry		1.0	8	8
45	Highland		2.0	6	12
46	Isle of Wight		3.0	9	27
47	James City		3.0	6	18
48	King George		3.0	10	30
49	King and Queen		3.0	10	30
50	King William		3.0	10	30
51	Lancaster		3.0	10	30
52	Lee		2.0	6	12
53	Loudoun	W. of Rte. 15	2.0	4	8
		E. of Rte. 15	1.0	4	4
54	Louisa		1.5	5	7.5
55	Lunenburg		1.5	5	7.5
56	Madison		1.0	5	5
57	Mathews		3.0	10	30
58	Mecklenburg		1.5	7	10.5
59	Middlesex		3.0	10	30
60	Montgomery		2.0	5	10
61	Suffolk		3.0	9	27
62	Nelson		1.5	5	7.5
63	New Kent		3.0	9	27
* 121	Newport News		3.0	9	27
* 122	Norfolk		3.0	9	27

APPENDIX I continued

Table of Values by County					
County Code	County		RF	CBR	SSV
65	Northampton		3.0	7	21
66	Northumberland		3.0	10	30
67	Nottoway		1.5	8	12
68	Orange	N. of Rte. 20 & E. of Rte. 522	1.0	6	6
		N. of Rte. 20 & W. of Rte. 522	1.0	5	5
		S. of Rte. 20 & E. of Rte. 522	1.5	6	9
		S. of Rte. 20 & W. of Rte. 522	1.5	5	7.5
69	Page	W. Alma	2.0	6	12
		E. Alma	1.0	6	6
70	Patrick		1.0	8	8
71	Pittsylvania		1.5	8	12
72	Powhatan	W. of Rte. 522 & of Rte. 609	1.5	7	10.5
		E. of Rte. 522 & of Rte. 609	2.5	7	17.5
73	Prince Edward		1.5	5	7.5
74	Prince George		3.0	8	24
76	Prince William	W. Rte. 95	1.0	4	4
		E. Rte. 95	3.0	7	21
77	Pulaski		2.0	5	10
78	Rappahannock	N. Flint Hill	2.0	5	10
		S. Flint Hill	1.0	5	5
79	Richmond		3.0	10	30
80	Roanoke		2.0	7	14
81	Rockbridge	W. of the James, Maury and South Rivers	2.0	5	10
		E. of the James, Maury and South Rivers	1.5	5	7.5
82	Rockingham	W. of Rte. 81	2.0	6	12
		E. of Rte. 81	1.0	6	6
83	Russell		2.0	6	12
84	Scott		2.0	6	12
85	Shenandoah		2.0	6	12
86	Smyth		2.0	6	12
87	Southampton		3.0	9	27

APPENDIX I continued

Table of Values by County					
County Code	**County**		**RF**	**CBR**	**SSV**
88	Spotsylvania	W. of Rte. 95	1.5	6	9
		E. of Rte. 95	2.5	10	25
89	Stafford	W. of Rte. 95	1.0	6	6
		E. of Rte. 95	3.0	10	30
90	Surry		3.0	9	27
91	Sussex	W. of Rte. 95	1.5	9	13.5
		E. of Rte. 95	3.0	9	27
92	Tazewell		2.0	6	12
* 134	Virginia Beach	N. of Rte. 44	3.0	9	27
		S. of Rte. 44	3.0	6	18
93	Warren		2.0	6	12
95	Washington		2.0	6	12
96	Westmoreland		3.0	10	30
97	Wise		2.0	6	12
98	Wythe		2.0	6	12
99	York		3.0	7	21

* Note: Arlington County, Henrico County, and independent cities identified with a "County Code" greater than 99 have administrative jurisdiction over their own transportation facilities. Consequently, for the development of new subdivision streets, the provisions of this guide may not apply in those jurisdictions and developers are encouraged to seek the guidance of appropriate authorities in those areas. However, these provisions shall apply in those jurisdictions for all the Department managed projects.

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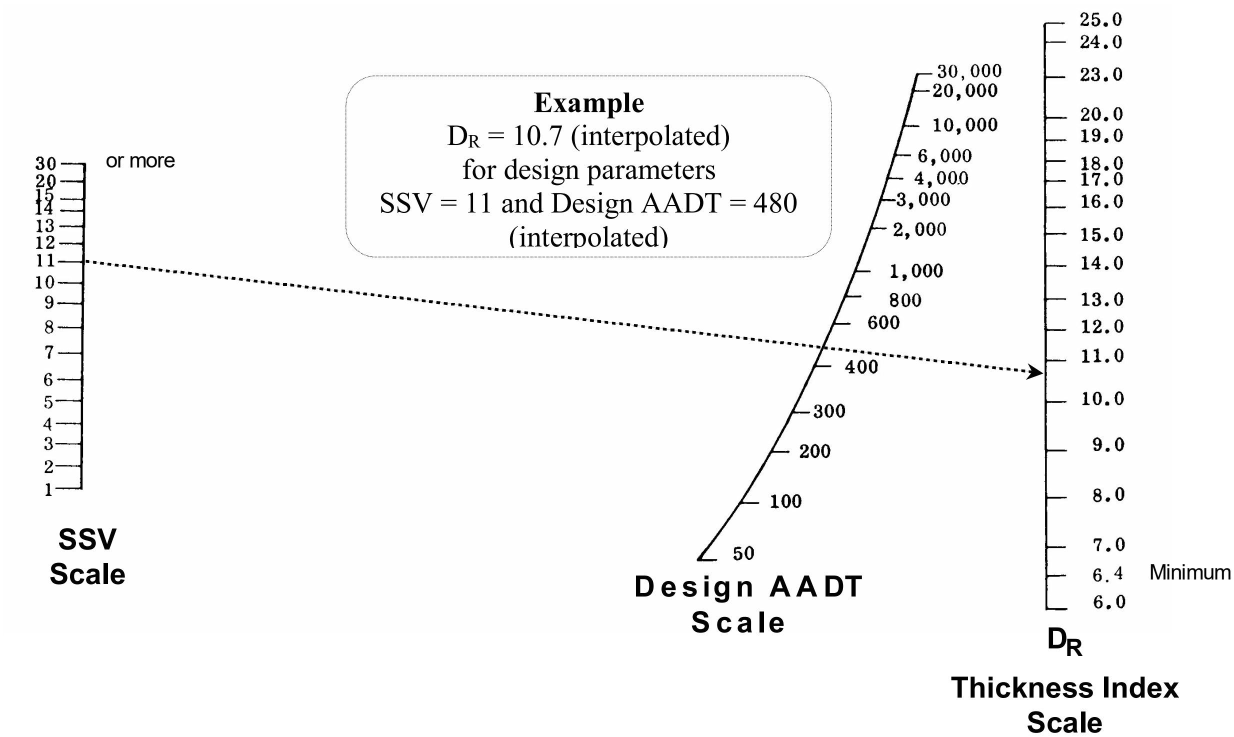
Appendix II
Nomograph for Determining Required Pavement Thickness Index D_R

(Note: An enlarged version of this nomograph is provided on the last page of this reference.)

Final pavement design must be based on the results of appropriate soil tests.

Preliminary designs may be based on values established in Appendix I.

To determine D_R, project a line from the value for SSV through the value for the Design AADT.



The nomograph depicted correlates the soil support value of the subgrade (SSV = Design CBR x RF), the traffic volume (Design AADT), and the minimum required pavement design thickness index (D_R) for subdivision streets and secondary road pavement, based on AASHO design equations. The equation on which the nomograph is based is: $D_R = 3.48\text{Ln (AADT)} - 1.48\text{Ln (SSV)} - 7.23$, where Ln is the natural logarithm. This nomograph assumes the following:

1. Use of Design AADT for two way traffic, equally distributed, thereby deriving the thickness index (D_R) required for any portion of the pavement to support one-half of the design AADT.
2. For D_R greater than 20, staged construction providing an initial stage D_R value of 20 may be permitted or the road can be designed using primary pavement methodology.
3. The District Materials Engineer may consider reducing the minimum D_R value of 6.4 for secondary system facilities having a Design AADT <50.

APPENDIX III

Paving Materials & Allowable Values

Location & Notation	Material	Material Notation	Thickness Equivalency Value	Lift Thickness Min. inches	Lift Thickness Max. inches	Max. No. of Lifts in a Design
Surface a1	Asphalt Concrete (SM-4.75A or D)[1]	A.C.	1.67 *	0.5	1	1
	Asphalt Concrete (SM-9.0A or D)[1]			1	1.5	1[3]
	Asphalt Concrete (SM-9.5A or D)[1]			1	1.5[2]	
	Asphalt Concrete (SM-12.5A or D)[1]			1.25	2	
	Prime & Double Seal or Class “C” or D” Blotted Seal Coat Surface Treatments [4]	D.S.	0.84	—	—	1
Intermediate a1	Asphalt Concrete (IM-19.0A or D) [1]	A.C.	1.67 *	2	3	1
Base a2	Asphalt Concrete (BM-25.0A or D) [1]	A.C.	1.67 *	2.5	4	Multiple[6]
	Full Depth Asphalt Concrete (BM-25.0A or D) over Subgrade[1]	A.C.	2.15 **	2.5	4	Multiple[6]
	Cold Central Plant Recycling Material[7]	CCPRM	1.33[7]	3	6	Mulitple[6]
	Untreated Aggregate [5]	Agg.	1.00	6	10	See Note[5]
	Cement Treated Aggregate[6]	CTA	1.67			Multiple[6]
	Cement Treated Select Material, Type II[6], min. CBR = 20	Sel. Mat. C	1.50			
	Select Material Type I & II, non-plastic[5], min. CBR = 30	Sel. Mat.	0.84			See Note[5]
	Select Material, Type II, non-plastic[5], min. CBR = 20	Sel. Mat.	0.60			
	Soil Cement[6]	S.C.	1.00			Multiple[6]
	Cement Treated Select Material, Type II[6]	Sel. Mat. C	1.17			
	Cement Treated Select Borrow[6]	Sel. Bor. C	1.00			
	Full Depth Reclamation	FDR	1.67	6	12	1
	Open Graded Drainage Layer	OGDL	0.60	2	3	1
Subbase a3	Untreated Aggregate [5]	Agg.	0.60			See Note[5]
	Cement Treated Aggregate[6]	CTA	1.33			Multiple[6]
	Full Depth Reclamation[8]	FDR	1.67	6	12	1
	Select Material Type I, non-plastic[5], min. CBR = 30	Sel. Mat.	0.50	4	10	See Note[5]
	Select Material Type II, non-plastic[5], min. CBR = 20	Sel. Mat.	0.40			
	Soil Cement[6]	S.C.	1.00	6	8	Multiple[6]
	Soil Lime[6]	S.L.	0.92			
	Cement Treated Select Material, Type II[6]	Sel. Mat. C	1.17			
	Cement Treated Select Borrow[6]	Sel. Bor. C	1.00			

Footnotes for Appendix III

1 When 4½ inches or more of any combination of Asphalt Concrete layers (surface + intermediate + base) is called for on top of a subbase layer, the thickness equivalency value of 2.25 * shall be used for all the asphalt concrete layers. When an asphalt base course is placed directly on subgrade, the resulting design is considered a "Full-Depth Asphalt Concrete" pavement. The total depth of asphalt concrete layers (surface + intermediate + base) in such pavement shall be at least 6 inches and an equivalency value of 2.15 ** shall be used for all the asphalt concrete layers.

2 When to be placed directly upon an aggregate base course, a 2" minimum thickness is required and placement in a single lift will be acceptable.

3 Two lifts of surface mix will be acceptable only under the case of phased construction where there will be at least a year time lapse between placement of the initial lift and the final surface lift placement. The thicknesses of the two lifts shall each conform to the minimum & maximum thicknesses in the table.

4 Prime and Double Seal Surface Treatment, in lieu of blotted seal coat surface treatment, may only be used as outlined in Appendix IV (for new subdivision streets) and the current Location and Design Division I&I Memorandum (for secondary road projects).

5 When untreated aggregate materials are used in a design, the maximum combined thickness shall be 12 inches for the purpose of calculating the thickness index value.

6 Multiple lifts of stabilized materials can be used in a design, as long as; they follow the General Notes and Specifications on page 14 of this Guide.

7 When the total depth of Asphalt Concrete layers and CCPRM is 4 ½ inches or more, a thickness equivalency value of 1.79 shall be used for CCPRM. When the total depth of Asphalt Concrete Layers and CCPRM is less than 4 ½ inches, a thickness equivalency value of 1.33 shall be used for CCPRM. CCPRM can be placed on untreated aggregate, stabilized materials or subgrade soil.

8 For routes where the design traffic exceeds two way Average Annual Daily Truck Traffic of 200, the cold pavement recycled materials (CCPRM or FDR) shall be covered with a multi-layer asphalt concrete overlay having a minimum combined thickness of 3.5 inches. For other situations, thinner than 3.5" of HMA overlay may be placed with the approval of the respective District Materials Engineer.

9 CCPRM and FDR should not be subject to extended traffic.

Appendix IV

Flexible Pavement Design Worksheet for New Subdivision Streets

This sheet is intended for use and submission in conjunction with VDOT's Secondary Street Acceptance Requirements

County		Date:
Subdivision		
Street Name		
Design Engineer		Phone:

AADT	Projected traffic for the street segment considered, as defined in the Subdivision Street Requirements.
CBR_D	Design CBR = Average of CBR_T x 2/3 and modified only as discussed in the Pavement Design Guide.
CBR_T	CBR value of the subgrade sample, taken and tested as specified in the Pavement Design Guide
DME	VDOT District Materials Engineer
EPT	Equivalent projected traffic
HCV	Number of Heavy Commercial Vehicles (e.g. trucks, buses, etc., with 2 or more axles and 6 or more tires).
%HCV	Percentage of the total traffic volume composed of Heavy Commercial Vehicles.
RF	Resiliency Factor = Relative value of the subgrade soil's ability to withstand repeated loading.
SSV	Soil support value of subgrade (SSV = CBR_D x RF)
D_P	Thickness index of proposed pavement design computed by the Conventional Pavement Design Method
D_R	Thickness index required, based on Design AADT and SSV, determined by Appendix II.

Step 1: Determine Design AADT

AADT	
%HCV = 100 (HCV / AADT) or EPT = 20 x HCV Note: For %HCV ≤ 5%, use AADT	________ Note: For %HCV>5%, EPT>AADT
Design AADT Use greater of AADT or EPT	

Step 2: Determine Design Values CBR, RF, and SSV

Sample No.	CBR_T
1	
2	
3	

Resiliency Factor (RF) Source	Value
Table 1	
Appendix I	
DME approved RF	

For preliminary designs, use the lowest RF value in the equation

CBR_D	x	RF	=	SSV
(_______)	x	(_______)	=	

Step 3: Pavement Design (Check appropriate box and show proposed pavement design below.)

☐ (A) Limited to Design AADT ≤ 400 - Show pavement material notations and thickness from Appendix IV Tables A and B.

☐ (B) Show pavement section as developed in the Pavement Design Guide. (See Appendix III for material notations and thickness equivalency values (a)).

D_R = _________ from Appendix II

Description of Proposed Pavement Section

	Material Notation	Thickness, h	a	(a x h)
Surface				
Base				
Subbase				

D_P must equal or exceed the value of D_R. $D_P = \Sigma$**(a x h)** =

Appendix IV - Table A Alternate Flexible Pavement Design Selection Chart

This table is to be used only in conjunction with the Flexible Pavement Design Worksheet for New Subdivision Streets.

DESIGN AADT		SUBBASE	BASE	SURFACE
Up to 250 AADT	1		8 inches Aggregate Base Material, Type I, Size No. 21A	Blotted Seal Coat - Type D (See Note A)
	2		8inches Soil Cement Stabilized (Native Soil or Borrow)	Blotted Seal Coat - Type C-1 (See Note A)
	3	4 inches Select Material, Type I, II or III, Minimum CBR 30	6 inches Aggregate Base Material, Type I, Size No. 21A	Blotted Seal Coat - Type D (See Note A)
	4	4" Cement or Lime Stabilized Subgrade	4 inches Aggregate Base Material, Type I, Size No. 21A	Blotted Seal Coat - Type D (See Note A)
Design Option shall only be used when SSV ≥ 10	5		3 inches Asphalt Concrete, Type BM-25.0	165 psy Asphalt Concrete, Type SM-9.5A or SM-12.5A
251 - 400 AADT	1	6 inches Select Material Type I or III, Minimum CBR 30	6 inches Aggregate Base Material, Type I, Size No. 21A	Blotted Seal Coat - Type D
	2		6 inches Local or Select Material, Minimum CBR 20, Stabilized With Cement	Blotted Seal Coat - Type C-1
	3		10 inches Aggregate Base Material, Type I, Size No. 21A	Blotted Seal Coat - Type D
	4	6 inches Cement Stabilized Subgrade	4 inches Aggregate Base Material, Type I, Size No. 21A	Blotted Seal Coat - Type D
Design option shall only be used when SSV ≥ 10	5		4 inches Asphalt Concrete, Type BM-25.0	165 psy Asphalt Concrete, Type SM-9.5A or SM-12.5A

Note A. For projected traffic volumes (Design AADT) up to 250 only, a prime and double seal surface may be used in lieu of a blotted seal coat.

Appendix IV - Table B Alternate Pavement Design Selection Adjustments

This table may only be used in conjunction with Appendix IV, Table A and its intended purpose.

SSV Under 10	SSV 10 to 20	SSV Over 20 (Maximum 30)
For each 5 SSV units under 10, the pavement design in Table A shall be increased by 0.5 inches of asphalt concrete or 1 inch of aggregate base material.	The pavement designs in Table A may be used as shown without adjustment.	The pavement designs in Table A may be decreased by 0.5 inches of asphalt concrete or 1.0 inch of aggregate base material.

APPENDIX V - Sample Pavement Design

A two lane road is proposed for construction in Prince William County, east of I-95, and will sustain a traffic count of 2500 with a growth rate of 3%, based on a September 2002 traffic count. Heavy commercial vehicles account for 6% of the traffic volume. Construction is expected to be finished in 2010. Soils tests yielded a classification of A-5 with 45% sand with no mica and a Design CBR of 6.3. The following designs might be considered.

Compute Design AADT = Present AADT x $[1 + (GR.)]^n$

Since %HCV > 5%, compute EPT and substitute result for the "Present ADT"

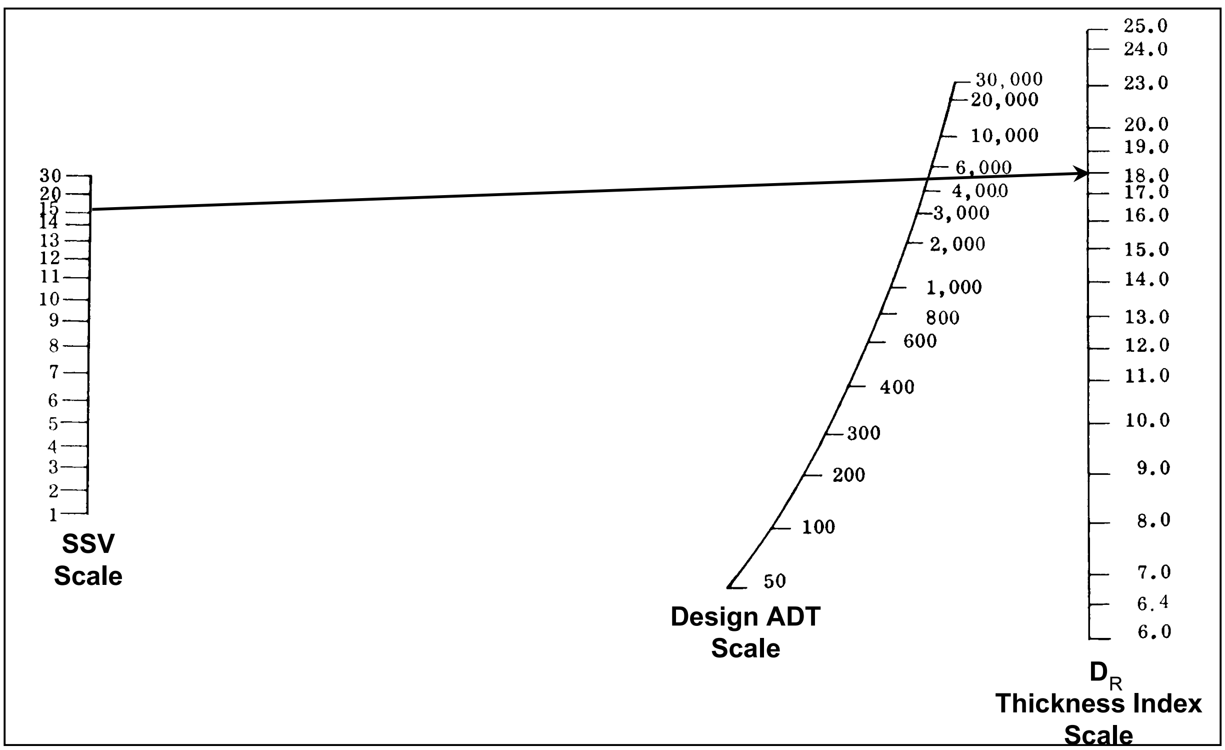
EPT = 2500 + 20 [2500(0.06 - 0.05)] = 2500 + 20 [25] = 3000

∴ USE ***Design AADT*** = $3000\,[1 + (0.03)]^{(10+2010-2002)}$

= $3000\,[1.03]^{18} = 3000\,[1.70] = 5100$ AADT

Compute SSV from Equation 1 SSV = 6.3 x 2.5 (ref. Table 1) = 15.75

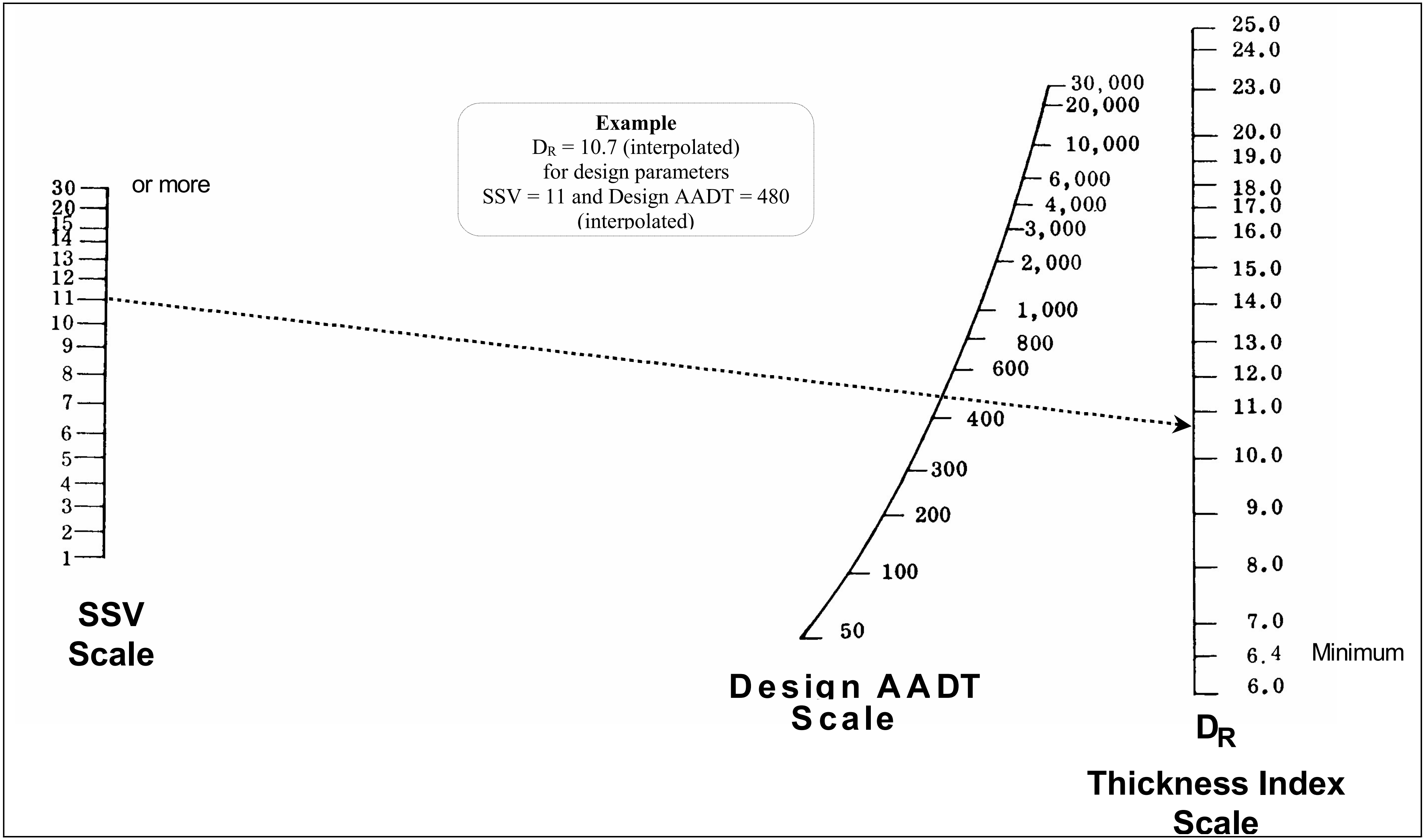
Required Design Thickness Index (D_R) from nomograph, Appendix II, is 18.



(Sample pavement designs appear on the next page.)

Trial	Pavement Layer	Materials Notation	Thickness (h), inches	Equivalency Value (a)	Layer Thickness Index (h x a)
1	Surface	Asphalt Concrete (SM-9.5A)	1.50	2.25	3.38
	Base	Asphalt Concrete (BM-25.0A)	5.00	2.25	11.25
	Subbase	Aggregate Base Material	6.00	0.60	3.60
		D_R = Total of "Layer Thickness Index Values" =			18.23
		Comment: Proposed trial pavement design is			**adequate.**
2	Surface	Asphalt Concrete (SM-9.5A)	1.50	2.25	3.38
	Base	Asphalt Concrete (BM-25.0A)	4.00	2.25	9.00
	Subbase	Soil Cement	6.00	1.00	6.00
		D_R = Total of "Layer Thickness Index Values" =			18.38
		Comment: Proposed trial pavement design is			**adequate.**
3	Surface	Asphalt Concrete (SM-9.5A)	1.50	2.15	3.23
	Base	Asphalt Concrete (BM-25.0A)	7.00	2.15	15.05
	Subbase	(Note: This is full depth asphalt.)			0.00
		D_R = Total of "Layer Thickness Index Values" =			18.28
		Comment: Proposed trial pavement design is			**adequate.**
4	Surface	Asphalt Concrete (SM-9.5A)	1.50	2.25	3.38
	Base	Asphalt Concrete (BM-25.0A)	3.50	2.25	7.88
	Subbase	2 Component Subbase: CTA	4.00	1.00	4.00
		plus Select Material, Type I	4.00	0.84	3.36
		D_R = Total of "Layer Thickness Index Values" =			18.61
		Comment: Proposed trial pavement design is			**adequate.**
5	Surface	Asphalt Concrete (SM-9.5A) @ 2 inches plus (IM-19.0A) @ 2.5 inches	4.50	2.25	10.13
	Base				
	Subbase	CTA	6.00	1.33	7.98
		D_R = Total of "Layer Thickness Index Values" =			18.11
		Comment: Proposed trial pavement design is			**adequate.**
6	Surface	Asphalt Concrete (SM-9.5A)	2.00	1.67	3.34
	Base	Aggregate Base Material	7.00	1.00	7.00
	Subbase	Soil Cement	8.00	1.00	8.00
		D_R = Total of "Layer Thickness Index Values" =			18.34
		Comment: Proposed trial pavement design is			**adequate.**
7	Surface	Asphalt Concrete (SM-9.5A)	1.50	2.25	3.38
	Intermediate	Asphalt Concrete (IM-19.0A)	2.00	2.25	4.50
	Base	CCPRM	4.00	1.79	7.16
	Subbase	Aggregate Base Materials	6.00	0.60	3.60
		D_R = Total of "Layer Thickness Index Values" =			18.64
		Comment: Proposed trial pavement design is			**adequate.**

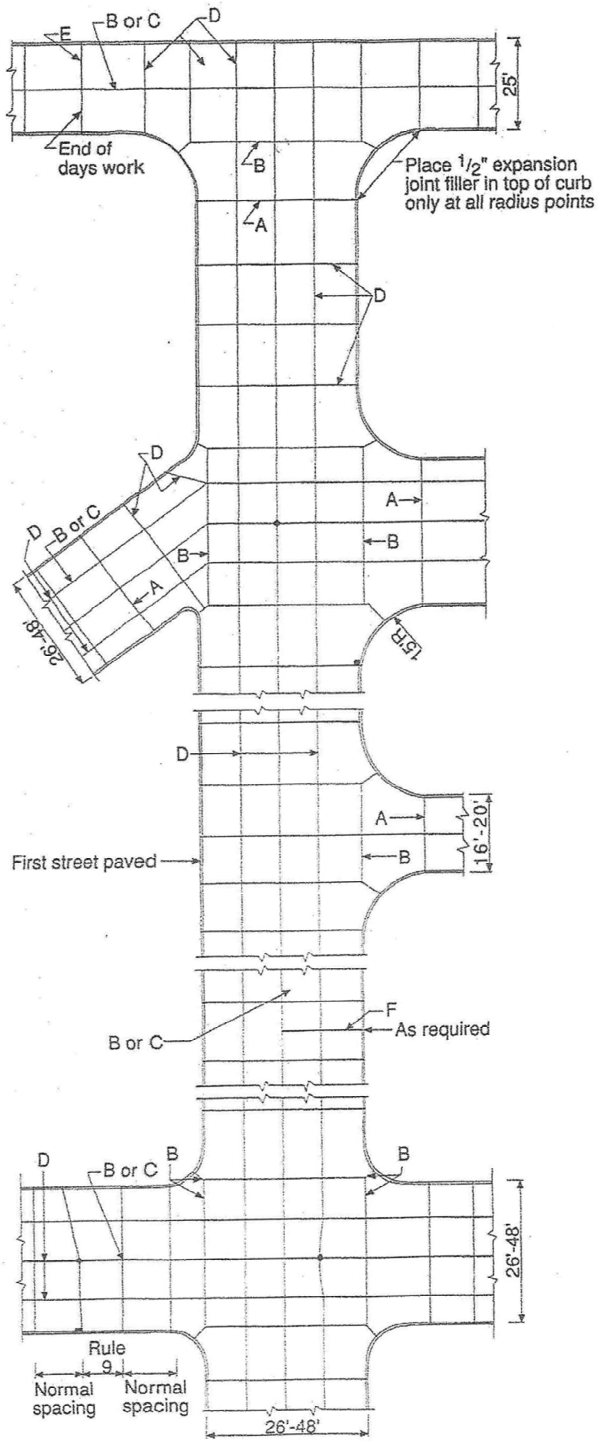
Since several "adequate" pavement design options are available, selection of a pavement design depends on the availability and cost of materials, underdrain requirements, ease of construction, and other factors.



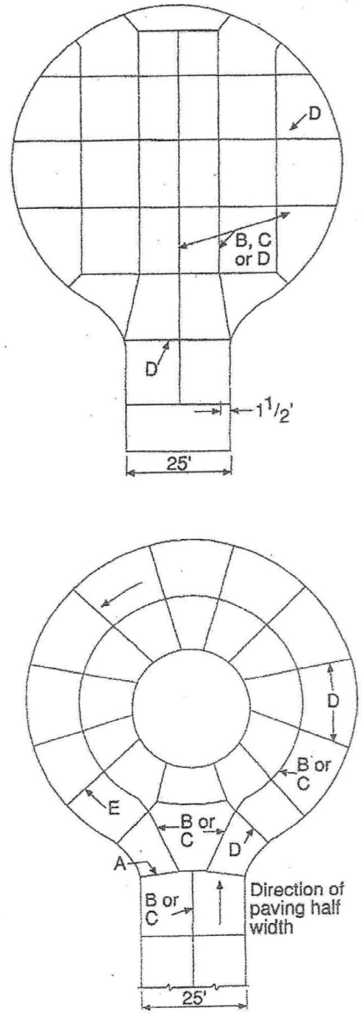
Please refer to Appendices II and V for the application of this diagram in the design of pavement.

APPENDIX VI: PCC Pavement Joint Detailing Example

Notes
A. Isolation joints
B. Longitudinal construction joints
C. Longitudinal contraction joints
D. Transverse contraction joint
E. Planned transverse construction joint
F. Emergency transverse construction joint



Pavement joints and cross section details



Plan of joint location for cul-de-sac