DESIGN METHOD FOR SECONDARY ROAD FLEXIBLE PAVEMENTS IN VIRGINIA
(Also Suggested for Subdivision and Other Road Systems)

by

N. K. Vaswani
Highway Research Engineer

Virginia Highway Research Council
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INTRODUCTION

The design method for secondary roads is based on AASHO Road Test Results and Virginia's design experience. It is divided into two parts: (1) the evaluation of the soil support value of the subgrade, the thickness equivalencies of the paving materials, and the traffic in terms of vehicles per day; and (2) design considerations such as the determination of the required thickness index of the pavement and the selection of the materials and layer thicknesses to meet the design thickness index.

THE EVALUATION OF VARIABLES

1) The Soil Support Value (SSV) = Design CBR* x resiliency factor. "The Virginia Test Method of Determining CBR Values" (VTM-8) is to be used for evaluating the design CBR. In unusual circumstances where actual CBR data cannot be obtained, predicted design values as given in Appendix I (page A-1) may be used. If these predicted values are used, the SSV of the subgrade can be obtained from Figure 1 (page 2) or Appendix I (page A-1).

The predicted regional resiliency factors are given in Figure 2 (page 3) and Appendix I. These factors are valid when the moisture content of the subgrade soil is at or below the plastic limit. For soils with moisture contents close to their liquid limits, the resiliency factors are much lower and the SSV should be a maximum of 2.

2) The Thickness Equivalencies of Paving Materials are given in Table 1, page 4. The materials and construction specifications should be in accordance with the current Virginia Department of Highways Road and Bridge Specifications or appropriate supplemental specifications.

3) The Traffic in Terms of Vehicles per Day (vpd) is available from district traffic engineers. For two-lane facilities provide for the total traffic. For four-lane use 80 percent of the total traffic.

*California Bearing Ratio

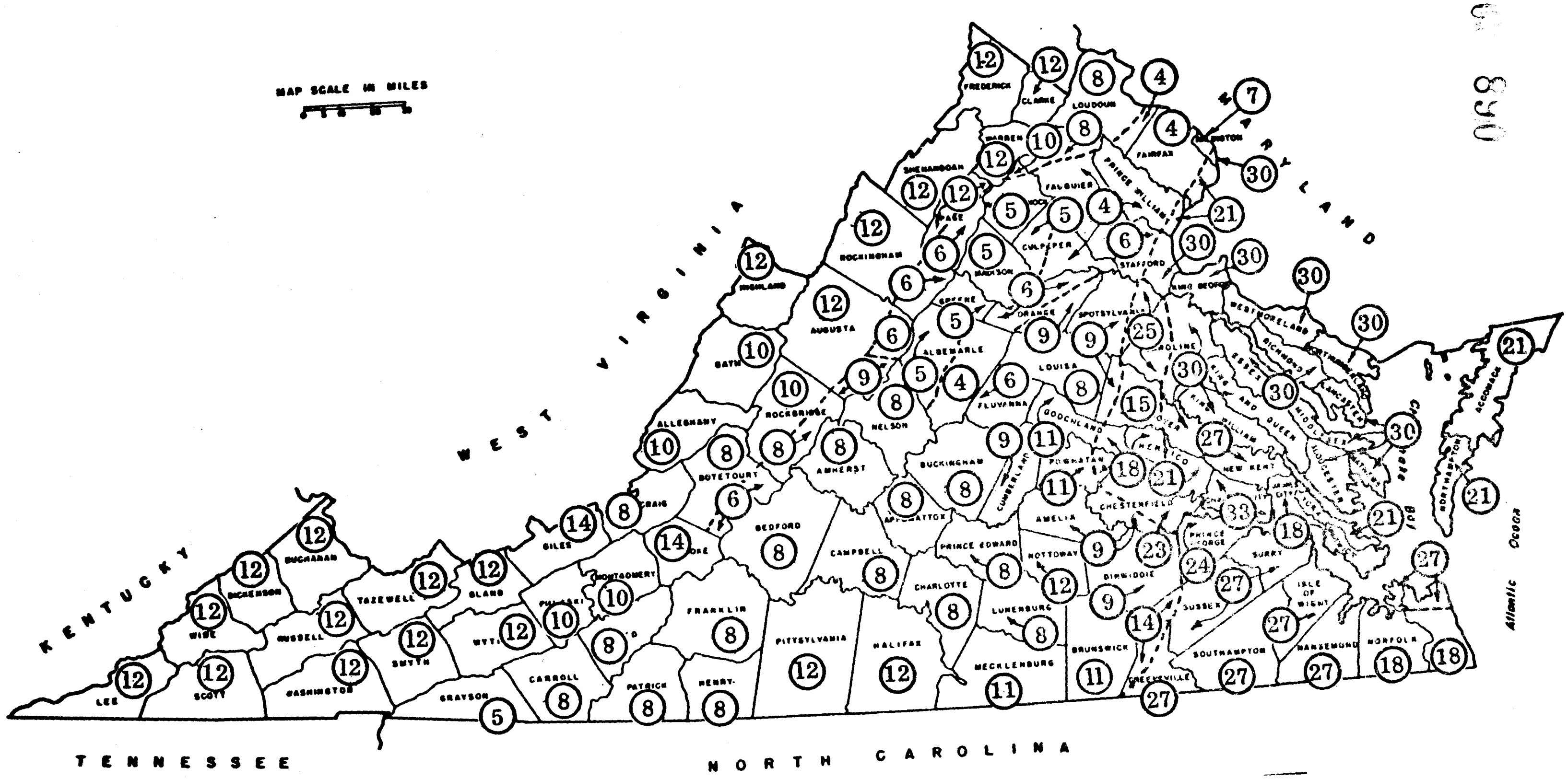


Figure 1. Predicted soil support values (SSV) for secondary and subdivisions roads.

Note: When the soil moisture content is in excess of the plastic limit and approache the liquid limit because of a high water table or other reasons, this chart should not be used to determine the SSV. In suc cases the SSV should have a maximum value of 2.

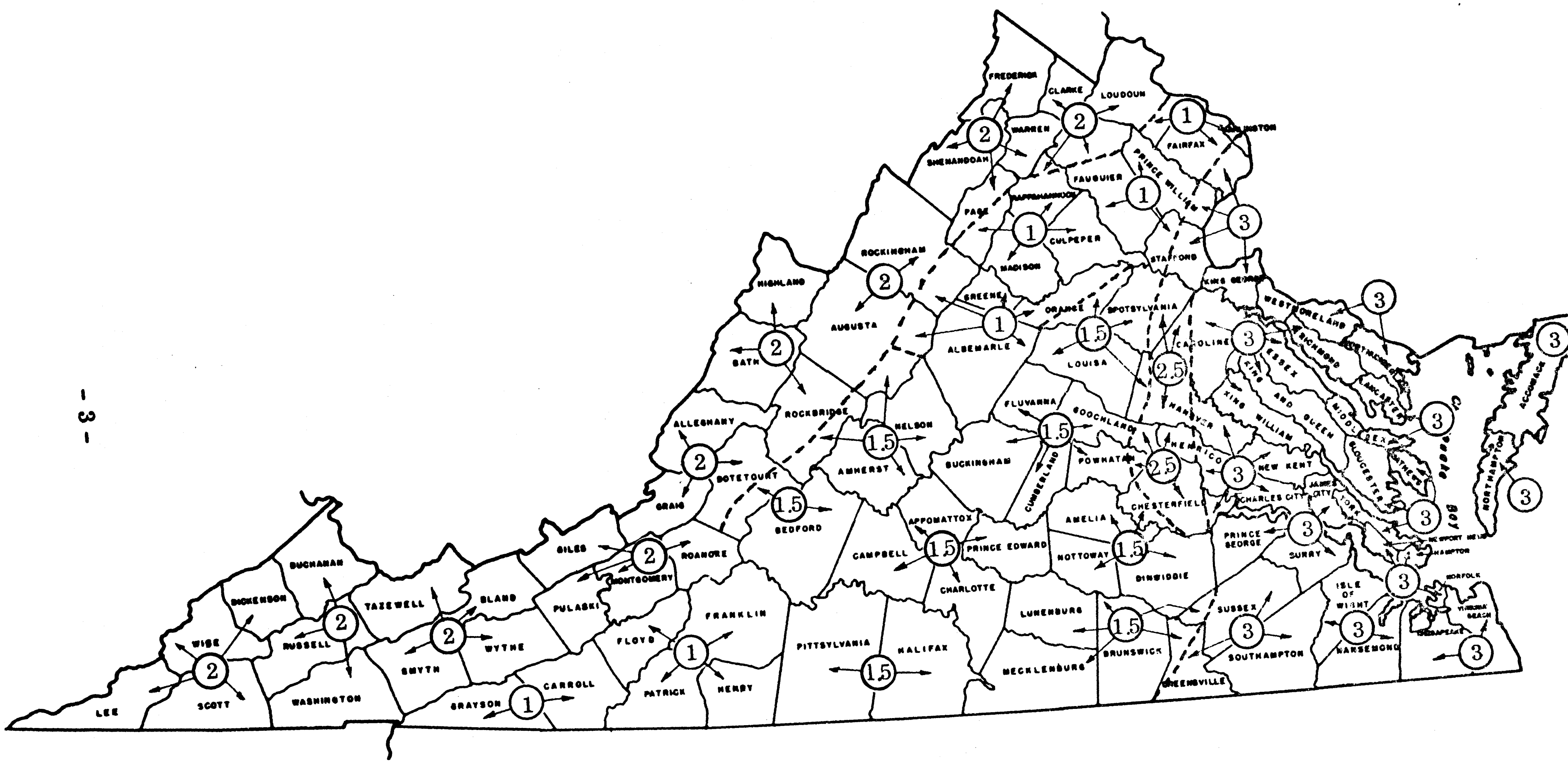


Figure 2. Soil resilience factors (RF) for secondary and subdivision roads.

TABLE 1

THICKNESS EQUIVALENCY VALUES FOR MATERIALS USED IN SECONDARY AND SUBDIVISION ROADS

Location	Location Notation	Material	Material Notation	Thick. Equiv. Value
Surface	a_1	Asphaltic Concrete (S-5)	A. C.	1. 67
	a_1	Prime and double seal *	D. S.	0. 84 *
	a_1	Prime and single seal *	S. S.	0. 42 *
Base	a_2	Asphaltic Concrete (B-3 or B-1)	A. C.	1. 67
	a_2	Untreated Aggregate	Agg.	1. 00
	a_2	Cement treated Aggregate	CTA	1. 67
	a_2	Sel. Mat. , Type I & III	Sel. Mat.	0. 84
	a_2	Soil Cement	S. C.	1. 00
	a_2	Cem. Tr. Sel. Mat. , Type II	Sel. Mat. C	1. 17
	a_2	Cem. Tr. Sel. Borrow	Sel. Bor. C	1. 00
Subbase	a_3	Untreated Aggregate	Agg.	0. 60
	a_3	Cement treated Aggregate	CTA	1. 33
	a_3	Sel. Mat., Type I & III	Sel. Mat.	0. 50
	a_3	Soil Cement	S. C.	1. 00
	a_3	Soil Lime	S. L.	0. 92
	a_3	Cem. tr. Sel. Mat. , Type II	Sel. Mat. C	1. 17
	a_3	Cem. tr. Sel. Borrow	Sel. Bor. C	1. 00

* Use this value for a_1h_1 as shown in examples 1, 2, and 3 given on pages 7, 8, and 9.

The design procedure is as follows: The design nomograph is given in Figure 3 (page 6). From the nomograph with a given SSV and vpd in both directions the thickness index (D) can be determined as shown by the example.

The nomograph specifies a minimum D of 6.4 and a maximum D of 20. The minimum D value could be reduced for service roads only. If the D value obtained from the nomograph is greater than 20, stage construction with D = 20 in the first stage may be provided.

After the value of D is obtained, the material in each layer of the pavement and the thickness of each layer can be determined by the following equation:

$$D = a_1h_1 + a_2h_2 + a_3h_3$$ (see Figure 4, page 10).

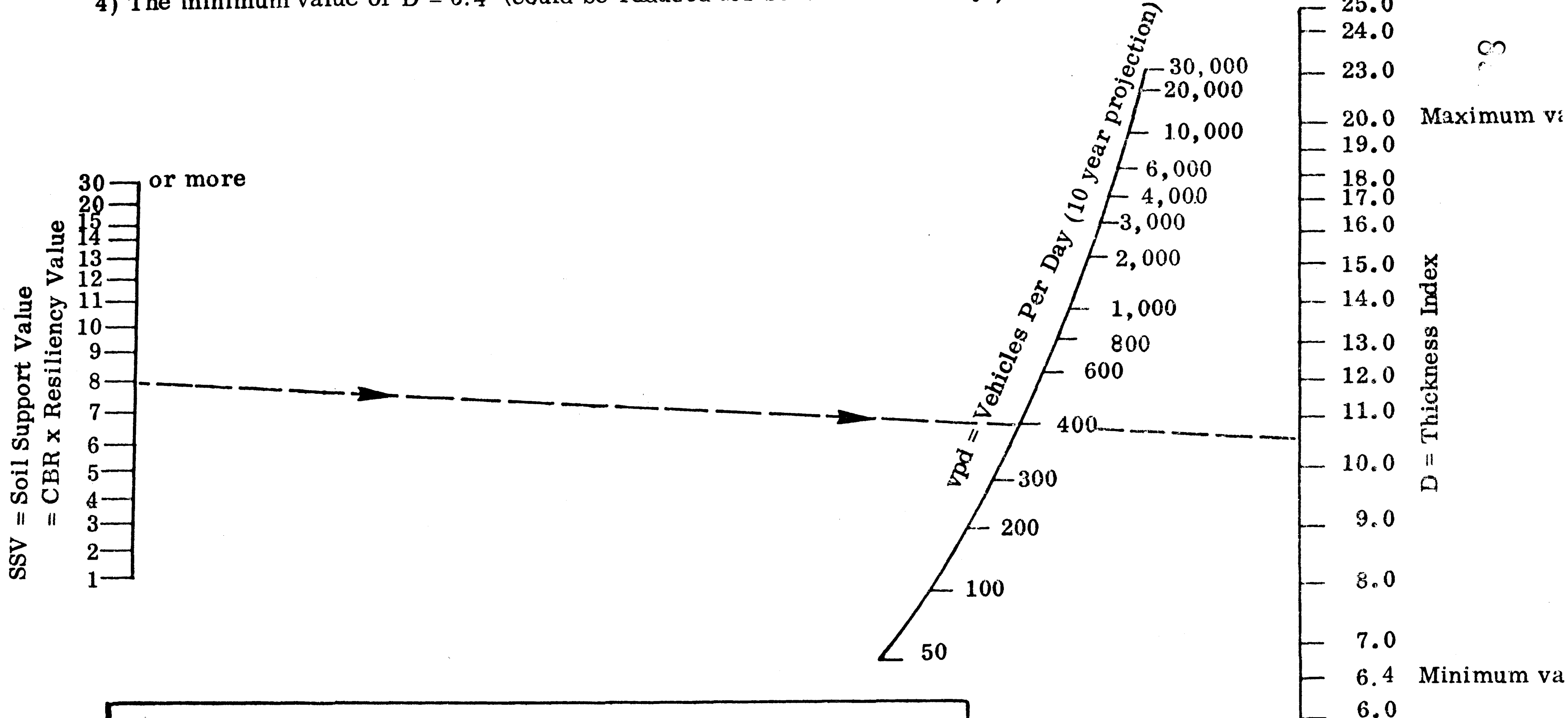
This is shown by three examples, given on pages 7, 8, and 9, using the data given below.

Example No. 1 — for sandy and sandy clay soils of the coastal plain and where the vpd = 150; 300, and 800.

Example No. 2 — for micaceous soils or micaceous clay silts and where the vpd = 350, 900, and 4,000.

Example No. 3 — for clayey soils with no mica content and where vpd = 200; 500, and 3,000.

Note: 1) vpd = vehicles per day in both directions.
2) The thickness index (D) is calculated, based on traffic in one direction.
3) Additional surface can be applied as stage construction when D is greater than 20.
4) The minimum value of D = 6.4 (could be reduced for service roads only)



Example: Given location — Craig County hence R. F. = 2.0
Given Av. CBR = 6 therefore Design CBR = 2/3 x 6 = 4
Therefore SSV = Design CBR x R. F. = 2 x 4 = 8
Given Traffic = 400 vpd (Total in both directions)
Therefore we get D = 10.6

Also see pages 7, 8 and 9.

Figure 3. Nomograph correlating the soil support value (SSV), traffic (vpd), and the thickness index (D) (based on AASHO Equation) for secondary and subdivision roads.

Example No. 1: <u>Data Collected</u>: 1) Average CBR = 15; 2) Sandy and Sandy Clay soils of coastal plains; 3) Three pavement designs for traffic of 150, 300 and 800 vpd are required with six choices in each case.

<u>Evaluation</u> : From Appendix II or Figure 3 the resiliency factor (R.F.) of the soil = 3.0; hence, SSV = Design CBR x R.F. = (2/3 x 15) x 3 = 30.
From nomograph (Figure 4) - (a) D = 6.4 for 150 vpd; (b) D = 8 for 300 vpd; and (c) D = 12 for 800 vpd.

(a) For 150 vpd, SSV = 30 and D = 6.4

Location	Material Notation*	Choice 1		Choice 2		Choice 3		Choice 4		Choice 5		Choice 6	
		h	hxa	h	hxa	h	hxa	h	hxa	h	hxa	h	hxa
Surface-a_1	A.C.	1	1.00x1.67=1.67	1	1.00x1.67=1.67	-		-		-		-	
Surface-a_1	D.S.	-		-			0.84	-		-			0.84
Surface-a_1	S.S.	-		-		-			0.42		0.42	-	
Base -a_2	Agg.	5	5.00x1.00=5.00	1		-		6	6.00x1.00=6.00	-		-	
Base -a_2	Sel.Mat.	-		6	6.00x0.84=5.04	7	7.00x0.84=5.88	-		-		-	
Base -a_2	Sel.Bor.C	-		-		-		-		6	6.00x1.00=6.00	6	6.00x1.00=6.00
	D		6.67		6.71		6.72		6.42		6.42		6.84

(b) For 300 vpd, SSV = 30 and D = 8

Location	Material Notation*	Choice 1		Choice 2		Choice 3		Choice 4		Choice 5		Choice 6	
		h	hxa	h	hxa	h	hxa	h	hxa	h	hxa	h	hxa
Surface-a_1	A.C.	1.25	1.25x1.67=2.09	1.25	1.25x1.67=2.09	-		-		-		-	
Surface-a_1	D.S.	-			0.84		0.84	-			0.84		0.84
Base -a_2	Agg.	6	6.00x1.00=6.00	7	7.00x1.00=7.00	5	5.00x1.00=5.00	-		-		-	
Base -a_2	Sel.Mat.	-		-		-		7	7.00x0.84=5.88	-		8	8.00x0.84=6.72
Base -a_2	Sel.Bor.C	-		-		-		-		7	7.00x1.00=7.00	-	
Subbase-a_3	S.C.	-		-		-				-		-	
Subbase-a_3	Sel.Mat.	-		-		4	4.00x0.5 =2.00	-		-		-	
	D		8.09		7.84		7.84		5.88		7.84		7.56

(c) For 800 vpd, SSV = 30 and D = 12

Location	Material Notation*	Choice 1		Choice 2		Choice 3		Choice 4		Choice 5		Choice 6	
		h	hxa	h	hxa	h	hxa	h	hxa	h	hxa	h	hxa
Surface-a_1	A.C. Full Dep.	8	8.00x1.5 =12.00	-		-		-		-		-	
Surface-a_1	A.C.	-		3.5	3.5x1.67 =5.85	2.5	2.5x1.67 =4.18	4	4.00x1.67=6.68	1.25	1.25x1.67=2.09	1.5	1.5x1.67 =2.51
Base -a_2	Agg.	-		6	6.00x1.00=6.00	8	8.00x1.00=8.00	-		4	4.00x1.00=4.00	3	3.00x1.00=3.00
Base -a_2	Sel.Mat.	-		-		-		6	6.00x0.84=5.04	-		-	
Subbase-a_3	Sel.Bor.C	-		-		-		-		-		6	6.00x1.00=6.00
Subbase-a_3	S.C.	-		-		-		-		6	6.00x1.00=6.00	-	
	D		12.00		11.85		12.18		11.72		12.09		11.51

*A.C. Full Dep. = Asphalt concrete full depth; A.C. = asphalt concrete; D.S. = double seal; S.S. = single seal; Agg. = untreated aggregate; Sel. Mat. = select material Type I or III; Sel. Bor. C = select borrow (Minimum CBR = 20) cement treated; S.C. = soil cement.

... designs for traffic of 350, 900 and 4,000 vpd required, with six choices in each case.

Evaluation : From Appendix I or II or Figure 3 the resiliency factor (R.F.) of the soil = 1.0; hence, SSV = Design CBR x R.F. = (2/3 x 10.5) x 1 = 7.
From nomograph (Figure 4) - (a) D = 10.0 for 350 vpd; (b) D = 14.0 for 900 vpd; and (c) D = 18.8 for 4,000 vpd

(a) For 350 vpd, SSV = 7.0 and D = 10.0

Location	Material Notation*	Choice 1		Choice 2		Choice 3		Choice 4		Choice 5		Choice 6	
		h	hxa	h	hxa	h	hxa	h	hxa	h	hxa	h	hxa
Surface-a_1	A.C.	1.5	1.5x1.67 =2.51	1.5	1.5x1.67 =2.51	-		-		-		-	
Surface-a_1	D.S.	-		-			0.84		0.84		0.84		0.84
Base -a_2	Agg.	8	8.00x1.00=8.00	6	6.00x1.00=6.00	4	4.00x1.00=4.00	4	4.00x1.00=4.00	4	4.00x1.00=4.00	3	3.00x1.00=3.00
Subbase-a_3	S.C.	-		-		6	6.00x1.00=6.00	-		-		-	
Subbase-a_3	S.L.	-		-		-		6	6.00x0.92=5.52	-		-	
Subbase-a_3	CTA	-		-		-		-		4	4.00x1.33=5.32	-	
Subbase-a_3	Sel.Mat.C	-		-		-		-		-		6	6.00x1.17=7.02
Subbase-a_3	Sel.Mat.	-		4	4.00x0.5 =2.00	-		-		-		-	
	D		10.51		10.51		10.84		10.36		10.16		10.86

(b) For 900 vpd, SSV = 7.0 and D = 14.0

Location	Material Notation*	Choice 1		Choice 2		Choice 3		Choice 4		Choice 5		Choice 6	
		h	hxa	h	hxa	h	hxa	h	hxa	h	hxa	h	hxa
Surface-a_1	A.C.	4	4.00x1.67=6.68	4	4.00x1.67=6.68	2.5	2.5x1.67 =4.18	2.5	2.5x1.67 =4.18	2.5	2.5x1.67 =4.18	2.5	2.5x1.67 =4.18
Base -a_2	Agg.	8	8.00x1.00=8.00	6	6.00x1.00=6.00	4	4.00x1.00=4.00	4	4.00x1.00=4.00	4	4.00x1.00=4.00	3	3.00x1.00=3.00
Subbase-a_3	S.C.	-		-		6	6.00x1.00=6.00	-		-		-	
Subbase-a_3	S.L.	-		-		-		6	6.00x0.92=5.52	-		-	
Subbase-a_3	CTA	-		-		-		-		4	4.00x1.33=5.32	-	
Subbase-a_3	Sel.Mat.C	-		-		-		-		-		6	6.00x1.17=7.02
Subbase-a_3	Sel.Mat.	-		4	4.00x0.5 =2.00	-		-		-		-	
	D		14.68		14.68		14.18		13.70		13.50		14.20

(c) For 4,000 vpd, SSV = 7.0 and D = 18.8

Location	Material Notation*	Choice 1		Choice 2		Choice 3		Choice 4		Choice 5		Choice 6	
		h	hxa	h	hxa	h	hxa	h	hxa	h	hxa	h	hxa
Surface-a_1	A.C. Full Dep.	12.5	12.5x1.5=18.75	-		-		-		-		-	
Surface-a_1	A.C.	-		5.5	5.5x1.67 =9.18	5	5.00x1.67=8.35	5.5	5.5x1.67 =9.19	4.0	4.00x1.67=6.68	4.5	4.5x1.67 =7.52
Base -a_2	CTA	-		6.0	6.0x1.67 =10.02	-		-		-		-	
Base -a_2	Agg.	-		-		4	4.00x1.00=4.00	4	4.00x1.00=4.00	4	4.00x1.00=4.00	4	4.00x1.00=4.00
Subbase-a_3	S.C.	-		-		6	6.00x1.00=6.00	-		-		-	
Subbase-a_3	S.L.	-		-		-		6	6.00x0.92=5.52	-		-	
Subbase-a_3	CTA	-		-		-		-		6	6.00x1.33=7.98	-	
Subbase-a_3	Sel.Mat.C	-		-		-		-		-		6	6.00x1.17=7.02
	D		18.75		19.20		18.35		18.71		18.66		18.54

*A.C. Full Depth = Asphalt concrete full depth; A.C. = asphalt concrete; CTA = cement treated aggregate; Agg. = untreated aggregate; S.C. = soil cement; S.L. = soil lime; Sel. Mat. C = cement treated select material, Type II; Sel. Mat. = select material Types I and III.

Example No. 3: Data Collected: 1) Average CBR = 9; 2) Clayey soils with no mica content of Valley & Ridge ; 3) Three pavement designs for traffic of 200, 500 and 3000 vpd required with six choices in each case.

Evaluation : From Appendix I or II or Figure 3 the resiliency factor (R.F.) of the soil = 2.0; hence, SSV = Design CBR x R.F. = (2/3 x 9) x 2 = 12.
From nomograph (Figure 4) - (a) D = 7.4 for 200 vpd; (b) D = 11 for 500 vpd; and (c) D = 16.8 for 3,000 vpd.

(a) For 200 vpd, SSV = 12 and D = 7.4

Location	Material Notation*	Choice 1		Choice 2		Choice 3		Choice 4		Choice 5		Choice 6	
		h	hxa	h	hxa	h	hxa	h	hxa	h	hxa	h	hxa
Surface-a_1	A.C.	1.5	1.5x1.67 =2.50	-		-		-		-		-	
Surface-a_1	D.S.	-			0.84		0.84	-		-		-	
Surface-a_1	S.S.	-		-		-			0.42		0.42		0.42
Base -a_2	Agg.	5	5.00x1.00=5.00	6	6.00x1.00=6.00	-		7	7.00x1.00=7.00	-		4	4.00x1.00=4.00
Base -a_2	Sel.Mat.	-		-		8	8.00x0.84=6.72	-		8	8.00x0.84=6.72	-	
Subbase-a_3	Sel.Mat.	-		-		-		-		-		6	6.00x0.5 =3.00
	D		7.50		6.84		7.56		7.42		7.04		7.42

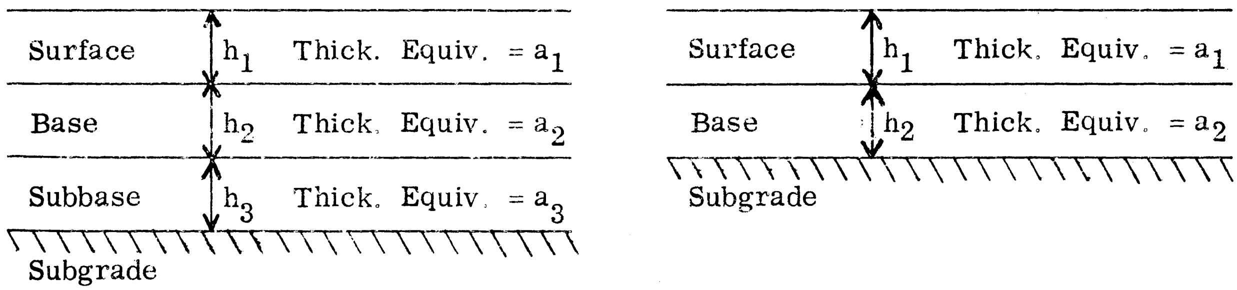
(b) For 500 vpd, SSV = 12 and D = 11.0

Location	Material Notation*	Choice 1		Choice 2		Choice 3		Choice 4		Choice 5		Choice 6	
		h	hxa	h	hxa	h	hxa	h	hxa	h	hxa	h	hxa
Surface-a_1	A.C.	1.5	1.5x1.67 =2.51	1.5	1.5x1.67=2.51	-		-		-		-	
Surface-a_1	D.S.	-		-			0.84		0.84		0.84		0.84
Base -a_2	Agg.	6	6.00x1.00=6.00	3	3.00x1.00=3.00	3	4.00x1.00= 4.00	4	4.00x1.00=4.00	3	3.00x1.00=3.00	-	
Base -a_2	Sel.Mat.	-		-		-		-		-		4	4.00x0.84=3.36
Subbase-a_3	S.C.	-		-		6	6.00x1.00=6.00	-		-		-	
Subbase-a_3	S.L.	-		-		-		6	6.00x0.92=5.52	-		-	
Subbase-a_3	CTA	-		4	4.00x1.33=5.32	-		-		6	6.00x1.33=7.98	-	
Subbase-a_3	Sel.Mat.C	-		-		-		-		-		6	6.00x1.17=7.02
Subbase-a_3	Sel.Mat.	4	4.00.0.5 =2.00	-		-		-		-		-	
	D		10.51		10.83		10.84		10.36		11.82		11.2

(c) For 3,000 vpd, SSV = 12 and D = 16.8

Location	Material Notation*	Choice 1		Choice 2		Choice 3		Choice 4		Choice 5		Choice 6	
		h	hxa	h	hxa	h	hxa	h	hxa	h	hxa	h	hxa
Surface-a_1	A.C.	6	6.00x1.67=10.02	4	4.00x1.67=6.68	5	5.00x1.67=8.35	4	4.00x1.67=6.68	4	4.00x1.67=6.68	4	4.00x1.67=6.68
Base -a_2	Agg.	6	6.00x1.00=6.00	4	4.00x1.00=4.00	3	3.00x1.00=3.00	3	3.00x1.00=3.00	6	6.00x1.00=6.00	-	
Base -a_2	Sel.Mat.	-		-		-		-		-		4	4.00x0.84=3.36
Subbase-a_3	S.C.	-		6	6.00x1.00=6.00	-		-		-		-	
Subbase-a_3	S.L.	-		-		6	6.00x0.92=5.52	-		-		-	
Subbase-a_3	CTA	-		-		-		6	6.00x1.33=7.98	-		-	
Subbase-a_3	Sel.Mat.C	-		-		-		-		-		6	6.00x1.17=7.02
Subbase-a_3	Sel.Mat.	-		-		-		-		8	8.00x0.5=4.00	-	
	D		16.02		16.68		16.87		17.66		16.68		17.06

The flexible pavements of secondary roads in Virginia usually consist of two or three layers of different materials of varying depth over the subgrade, as shown in Figure 4 below.



(a) Three-layer System (b) Two-layer System

Figure 4. Secondary road flexible pavement sections.

CBR Values

For each project sufficient CBR tests should be run to determine the true support value of the various soils in the subgrade.

The average CBR value of the project is the average of the CBR test values after rejecting the very low and very high values.

The design CBR value of the project is two-thirds of the average CBR value of the project. The factor of two-thirds is adopted as a safety factor to compensate for the nonuniformity of the soil encountered on the projects, and also to compensate for the very low bearing CBR samples which are not considered when computing the average CBR values of the soils encountered on the project. Further, four days of soaking — as specified in the test method — does not necessarily give the minimum CBR strength of some soils. Thus the two-thirds factor would compensate for all such variations.

Resiliency Factor (RF)

The subgrade soils for secondary and subdivision roads have been divided into five classifications based on their resiliency properties. The resiliency factors are given in Table 2 below. Please note that the higher the resiliency, the lower the resiliency factor. The degree of resiliency of a soil could be obtained if its soil classification is known as shown in Appendix II, page A-6.

TABLE 2

RESILIENCY FACTORS FOR SOILS

Degree of Resiliency	RF
Highly resilient soils	1.0
Medium resilient soils	1.5
Medium low resilient soils	2.0
Low resilient soils	2.5
Very low resilient soils	3.0

Traffic

The design nomograph (Figure 3, page 6) has a vpd curve which shows the total traffic in both directions, since this is normally the way the total traffic volume is obtained on secondary roads. If the data available are for traffic in one direction (e.g., on a one-way street), this value should be doubled for use of this nomograph.

However, it should be noted that the thickness index (D) curve is calculated based on one direction traffic only, and hence gives the thickness index of the pavement in each traffic lane.

The nomograph assumes truck traffic (2 axles and six tires or heavier) not greater than 5 percent. For truck traffic greater than 5 percent the thickness index of the pavement should be increased as follows: For every 50 trucks (2 axles and 6 tires or heavier) over the 5 percent level, the thickness index (D) as obtained from the nomograph should be increased by 1.

The Thickness Equivalency

The thickness equivalency (a) of a given material is the index of strength the material contributes to the pavement. Its value depends on the type of the material and its location in the pavement.

The strength equivalencies of the paving materials are given in Table 1. As new materials are introduced, their thickness equivalencies have to be evaluated. For full depth asphaltic concrete (consisting of an S-5 surface and the remainder B-3 base) placed directly on the subgrade, the tentative recommendations are that it should have a minimum thickness of 7 inches and a thickness equivalency of 1.5. The thickness equivalency of the same material when placed in the base is higher than when placed in the subbase. Thus untreated stone has a = 1.0 in the base course and a = 0.6 in the subbase course. Cement treated aggregate and select materials types I and III are similarly considered.

Investigations have shown that the strength of the cement treated native soil or borrowed materials (e.g., select material type II and select borrow) varies depending upon their physical and chemical properties. For this reason, the thickness equivalencies of such materials is kept the same whether they are placed in the base or in the subbase.

Thickness Index

The thickness index (D) is the strength of the pavement based on its resistance to a deflection caused by a wheel load. It is obtained by the equation

$$D = a_1h_1 + a_2h_2 + a_3h_3$$

when a_1, a_2, and a_3 are the thickness equivalencies of the materials in the surface, base, and subbase layers, and h_1, h_2, and h_3 are the thickness in inches of the surface, base, and subbase layers, respectively.

Sometimes a subbase may not be provided, and in this case $h_3 = 0$.

SOME DESIGN RECOMMENDATIONS

After the required thickness index of the pavement has been determined, the choice of material and the thickness of the layer are determined by the pavement designer. These decisions are usually based on dollar value, structural adequacy, and pavement serviceability. Based on design and construction experience, the following are recommended:

1) For a poor subgrade with low soil support values, stabilize the subgrade or subbase material with lime or cement to provide a rigid foundation.

A rigid foundation is a good investment where the traffic is likely to increase considerably. For example, a rigid foundation (e.g., 6" soil cement or soil lime) with 3 to 4" of untreated aggregate is capable of carrying a very high traffic volume.

2) Stabilized subgrades (particularly those stabilized with cement) should be immediately covered with untreated aggregate to eliminate or reduce moisture and thermal cracking or deterioration with a resultant lower strength of the stabilized material. This could normally be handled by a firm specification on requirement.

3) Cement stabilization should be completed before cold weather (say $40^{o}F$) sets in.

4) Marshy soils, or sandy soils with high subgrade moisture content, or subgrades with water springs or A-3 type soils should be stabilized with a suitable agent. If the subgrade strength is still considered to be weak in proportion to the expected amount of traffic, cement stabilized material may be provided over the stabilized subgrade.

5) Alternate type designs should be set up where practical to provide reasonable competition. This practice might attract more bids with resultant economies in construction cost.

ACKNOWLEDGEMENTS

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APPENDIX I

CLASSIFICATION BASED ON RESILIENCY AND CBR VALUES OF SOILS

Code	County or Town	Predicted Resiliency Factor	Predicted Design CBR Values	Predicted Soil Support Value (SSV) = (Res. Factor x Predicted CBR)
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	8
06	Appomattox	1.5	5	8
07	Augusta	2	6	12
08	Bath	2.0	5	10
09	Bedford	1.5	5	8
10	Bland	2.0	6	12
11	Botetourt — a bulge in the eastern rock, half way up to Eagle Rock.	1.5	4	6
	Remainder of county.	2.0	4	8
12	Brunswick	1.5	7	11
13	Buchanan	2.0	6	12
14	Buckingham	1.5	5	8
15	Campbell	1.5	5	8
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	11	33

90A

APPENDIX I (continued)

Code	County or Town	Predicted Resiliency Factor	Predicted Design CBR Values	Predicted Soil Support Value (SSV) = (Res. Factor x Predicted CBR)
19	Charlotte	1.5	5	8
131	Chesapeake	3.0	6	18
20	Chesterfield — S.W. Mosley and Colonial Heights	1.5	6	9
	Remainder of county	2.5	9	23
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	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. Rte. 522	1.5	7	11
	E. Rte. 522	2.5	7	18
38	Grayson	1.0	5	5
39	Greene	1.0	5	5
40	Greensville — E. Rte. 95	3.0	9	27
	W. Rte. 95	1.5	9	14

Code	County or Town	Predicted Resiliency Factor	Predicted Design CBR Values	Predicted Soil Support Value (SSV) = (Res. Factor x Predicted CBR)
41	Halifax	1.5	8	12
114	Hampton	3.0	9	27
42	Hanover — E. Rte. 95	3.0	10	30
	W. Rte. 95 and E. Rte. 715	2.5	6	15
	W. Rte. 715	1.5	6	9
43	Henrico — W. Rte. 95	2.5	7	18
	E. 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. Rte. 15	2.0	4	8
	E. Rte. 15	1.0	4	4
54	Louisa	1.5	5	7.5
55	Lunenberg	1.5	5	8
56	Madison	1.0	5	5
57	Mathews	3.0	10	30
58	Mecklenburg	1.5	7	11
59	Middlesex	3.0	10	30
60	Montgomery	2.0	5	10
61	Nansemond	3.0	9	27
62	Nelson	1.5	5	8
63	New Kent	3.0	9	27
121	Newport News	3.0	9	27

APPENDIX I (continued)

Code	County or Town	Predicted Resiliency Factor	Predicted Design CBR Values	Predicted Soil Support Value (SSV) = (Res. Factor x Predicted CBR)
122	Norfolk	3.0	9	27
65	Northampton	3.0	7	21
66	Northumberland	3.0	10	30
67	Nottoway	1.5	8	12
68	Orange — N. of Rte. 20 and E. Rte. 522	1.0	6	6
	N. of Rte. 20 and W. Rte. 522	1.0	5	5
	S. of Rte. 20 and E. Rte. 522	1.5	6	9
	S. of Rte. 20 and W. Rte. 522	1.5	5	8
69	Page — W. Alma	2.0	6	12
	E. Alma	1.0	6	6
70	Patrick	1	8	8
71	Pittsylvania	1.5	8	12
72	Powhatan — W. Rte. 522 and Rte. 609	1.5	7	11
	E. Rte. 522 and Rte. 609	2.5	7	18
73	Prince Edward	1.5	5	8
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. James, Maury, and South Rivers	2.0	5	10
	E. James, Maury, and South Rivers	1.5	5	8

APPENDIX I (continued)

Code	County or Town	Predicted Resiliency Factor	Predicted Design CBR Values	Predicted Soil Support Value (SSV) = (Res. Factor x Predicted CBR)
82	Rockingham — W. Rte. 81	2.0	6	12
	E. 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
88	Spotsylvania — W. Rte. 95	1.5	6	9
	E. Rte. 95	2.5	10	25
89	Stafford — W. Rte. 95	1.0	6	6
	E. Rte. 95	3.0	10	30
90	Surry	3.0	9	27
91	Sussex — W. Rte. 95	1.5	9	14
	E. Rte. 95	3.0	9	27
92	Tazewell	2.0	6	12
134	Virginia Beach — N. Rte. 44	3.0	9	27
	S. 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

APPENDIX II

EVALUATION OF SOIL RESILIENCY FACTORS

Soil Type	Zone	Resiliency Factor
Highly resilient soils -- (a) A-4 (with G. I. of 5 and up) having large percentage passing #200 but with low mica content. (b) Sandy silt with high mica content. Geologically they are high and low quartz granitoids.	Piedmont	1.0
Mediumly resilient soils -- A-7-5 or micaceous clay. Mostly they are silts without mica content.	Piedmont	1.5
Medium low resilient soils -- Clays: A-4-2, A-6, A-7-6, or A-8 (no mica content).	Valley & Ridge	2.0
Low resilient soils -- Combination of sand, silt and clays (no mica content).	Northern part of Richmond District	2.5
Very low resilient soils -- Sands: A-1, A-2, A-3, or A-4 (with G. I. less than 5). Geologically they are coastal plain sediments (no mica content).	Coastal plains	3.0