SURVEY ON THE USE OF STUDDED TIRES AND THEIR CONTRIBUTION TO PAVEMENT WEAR

by

Charles W. Payne
Highway Materials Technician

Virginia Highway Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia Department of Highways and the University of Virginia)

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PURPOSE

Since the legalization of studded tires in Virginia in 1968, yearly surveys have been conducted to determine the extent of their use. Along with the surveys, pavement wear measurements have been taken to determine if the tires are contributing appreciably to pavement wear.

The purpose of this report is to record the data gathered thus far so that they may be used with other information to develop recommendations for legislation regarding the use of studded tires in the state.

DATA GATHERING PROCEDURE

Survey Locations

Since 1968, approximately 4,500 vehicles in the Pentagon parking lots have been surveyed annually to determine the percentage equipped with studded tires. In addition, starting in 1972, surveys have been made of parking lots in Winchester, Verona, Salem, Bristol, and the Radford Arsenal. At Winchester, Verona, Salem and Bristol, large industrial parking lots were chosen for observation and at the Radford Arsenal three-fourths of the parking lots were selected. Although Bristol and Radford Arsenal are not part of the Shenandoah Valley, the survey data for them will be discussed with the results for the Shenandoah Valley locations in this report.

In conjunction with the observation of the cars at each parking lot, pavement wear measurements have been taken. In Northern Virginia the measurements have been made at eight sites on interstate roads; in the Valley only the primary roads providing access to the lots have been surveyed.

Wear Measurements

The pavement wear measurements are made by laying a metal straightedge across the pavement (Figure 1) and, with a tire tread depth gauge (Figure 2), determining the distance from the bottom of the straightedge to the pavement (Figure 3). The measurements are taken perpendicular to the centerline, at one foot intervals beginning at the inside edge of the pavement edge line and continuing for seven feet.

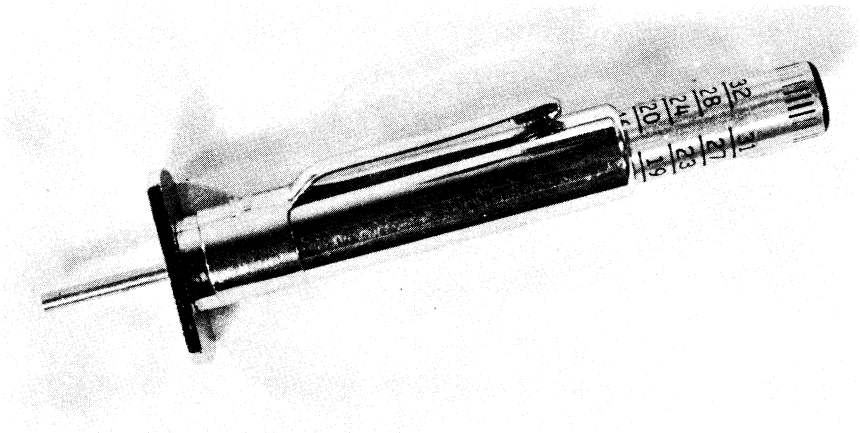


Figure 1. Tire measurement gauge.

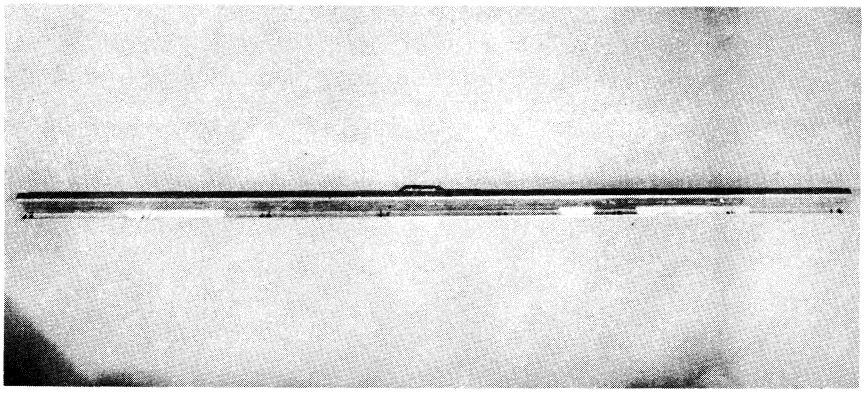


Figure 2. Measuring bar.

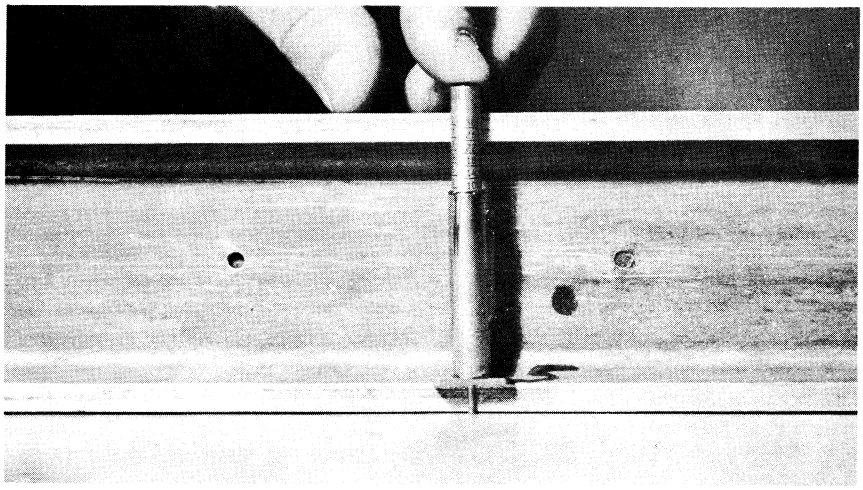


Figure 3. Measuring technique.

In Northern Virginia four repetitions of transverse testing were made at 6'3"-intervals, which is the spacing between the guardrail posts that were used as measuring points. However, in the Shenandoah Valley there were eight repetitions at each site but at much greater and random intervals. At each site the data for the repetitions were averaged, unless within one site there was more than one mix type; then the repetitions were analyzed and broken down into site number A, B, etc.

STUDDED TIRE USE DATA

The data on studded tire usage for the Pentagon and Shenandoah Valley parking lots surveyed are shown in Table 1. This table shows the total number of cars surveyed, the total number carrying studs, and the percentage of studded tire usage at each location. From the table it can be seen that there was an increase in usage from the beginning survey in 1969 through the first survey in 1971, then a decrease starting with the second survey in 1971 and continuing through the final survey in 1973. It can be noted that the largest percentage of studded tire use has been in the Shenandoah Valley locations.

TABLE 1

TIRE USE DATA

Location	Date	No. Cars Surveyed	No. Cars With Studs	% Cars With Studs
Pentagon	Feb. 1969	4,466	105	2.3
	Feb. 1970	4,337	180	4.1
	Feb. 1971	4,582	354	7.7
	Dec. 1971	4,315	288	6.7
	Jan. 1973	4,374	270	6.1
Bristol	1972	1,008	204	21
	Jan. 1973	996	136	13.7
Salem	1972	1,008	95	9.4
	Jan. 1973	1,010	92	9.1
Radford Arsenal	1972	966	140	14.1
	Jan. 1973	1,016	125	12.3
Verona	1972	1,034	180	17.3
	Jan. 1973	1,019	149	6.8
Winchester	1972	1,008	150	14.8
	Jan. 1973	1,016	135	7.5

Data on the state of registration, tread types, and the numbers and percentages of the types used on front and rear wheels are given in Tables A-1 and A-2 of the Appendix.

Yearly Accumulated Studded Tire Traffic

The accumulated studded tire traffic between test dates in December 1971 and January 1973 for each of the nine study sites is shown in Table 2. The average vehicles daily used in calculating the yearly figures excludes large trucks since they do not use studded tires. Also, the ramp sites are not included because no traffic data are available for them.

TABLE 2

YEARLY ACCUMULATED STUDDED TIRE TRAFFIC

Site	Location	Average Vehicles Daily	Accumulated Studded Tire Traffic
1	I-495 East of Rt. 241	66,500	97,039
2	I-495 ½-Mile West of Rt. 1	77,700	133,101
7	I-495 East of I-95	70,300	115,961
8	I-495 East of Rt. 613	66,000	113,059
9	Rt. 11 — Washington County (Between Abingdon and Bristol)	7,850	138,023
10	Rt. 419 Salem (From Rt. 1442 to 0.3 Mile East of Rt. 1424)	13,820	126,197
11	Rt. 114 Montgomery County (From 0.1 Mile South of New River Bridge to Rt. 659 North)	7,400	97,114
12	Rt. 11 Augusta (0.2 Mi. South of Rt. 275 to Intersection of Rt. 857)	4,710	59,184
13	Rt. 11 Frederick County (Intersection Rt. 649 to Intersection of Rt. 652)	4,440	50,952

Since the Northern Virginia sites were on six-lane roads and measurements were taken in the traffic lane, lane percentages from the Traffic Engineering Handbook were used in the following method of calculating the potential accumulated studded tire traffic:

$$2 \frac{\text{average vehicles daily}}{\text{number of directions}} \times \text{percent studded tire usage} \times 180 \text{ days (number of days studded tires were permitted between the test dates in December 1971 and March 1973)} \times \text{percent traffic for traffic lane.}$$

Figure 4 shows the yearly accumulated studded tire traffic versus the maximum depth wear for all sites in the study except the sites located on ramps. From this figure it can be seen that the accumulated studded tire traffic causes considerably more damage to limestone mixes than to other types of bituminous mixes and concrete mixes.

PAVEMENT WEAR DATA

The pavement measurement values for the past two years in Northern Virginia and the Shenandoah Valley are given in Figures 5 and 6 respectively. In these figures 0 represents the right-hand pavement edge stripe and the other numbers (1', 2', 3', etc.) indicate the distance from the edge stripe. Each vertical increment represents 1/32 inch of pavement wear. It can be noticed that on the interstate sites in Northern Virginia the major wear occurs from three to four feet from the pavement edge. This major wear point represents the wheel path and it is believed that its location is dependent upon the road type.

Given in Figure 7 are two-year data from four ramps in Northern Virginia. It is noted that the Northern Virginia survey has been carried out for the last five years, however, the first three years' data do not show the same trend as the data from the past two years. It is believed that this is due to the following factors: (1) testing error (the first two years' data were gathered by a different crew than the one that took these for the last three years), and (2) the third years' data were taken in March 1971 and the fourth years' in December 1971, thus the period between covered mostly summer months when little wear should be expected.

Pavement measurement data gathered in Northern Virginia for the past five years are given in the Appendix as Figure A-1.

It is believed that studded tires are more detrimental to certain mix types than to others. As can be seen in Figures 8 and 9, which show a coarse limestone mix on Rt. 114 in Montgomery County, the sand has been plucked out and the same thing is beginning to happen to the large aggregate.

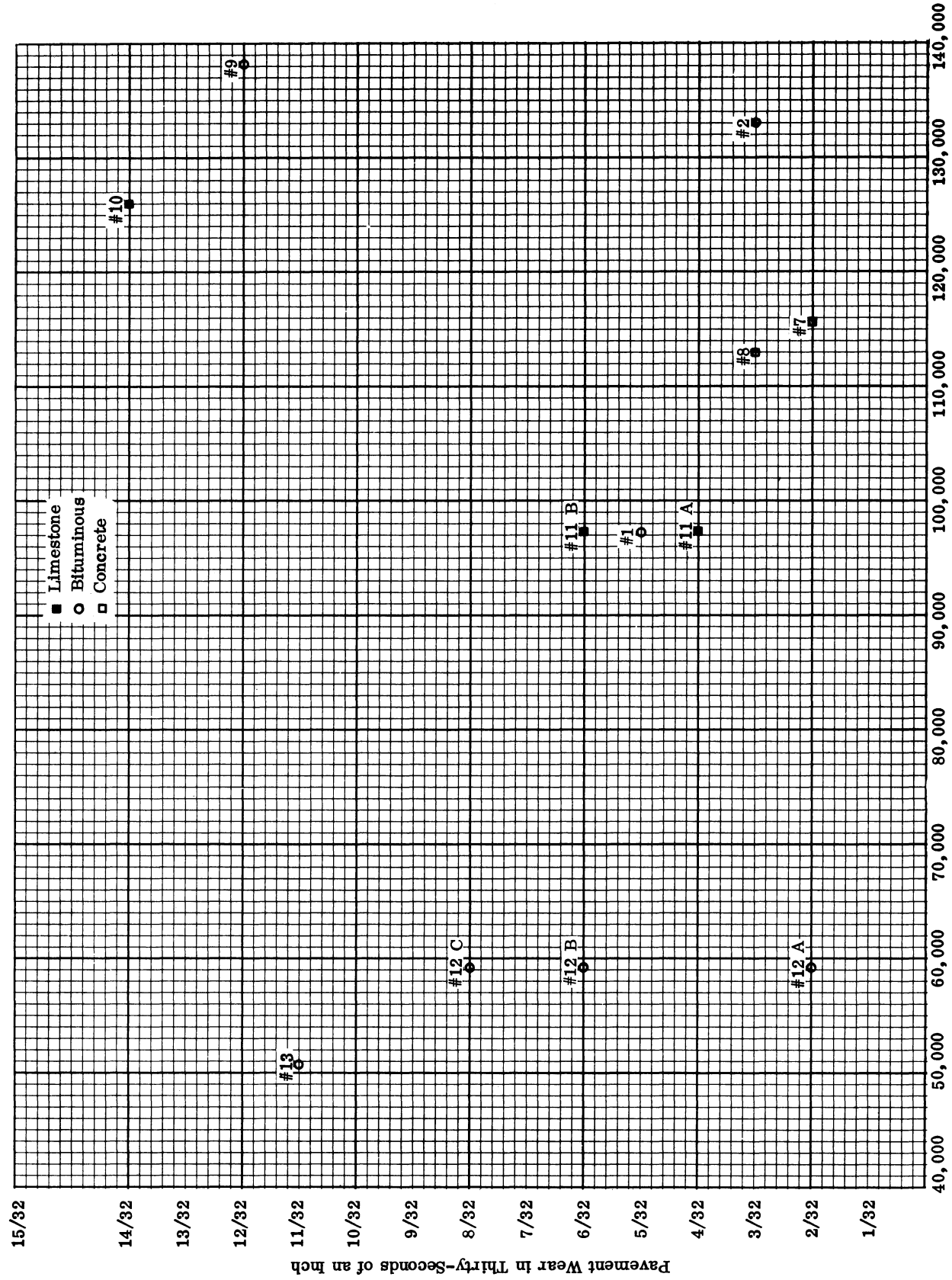


Figure 4. Yearly accumulated studded tire traffic versus maximum depth wear.

FIGURE 5

WEAR MEASUREMENTS ON PAVEMENTS

U 1298

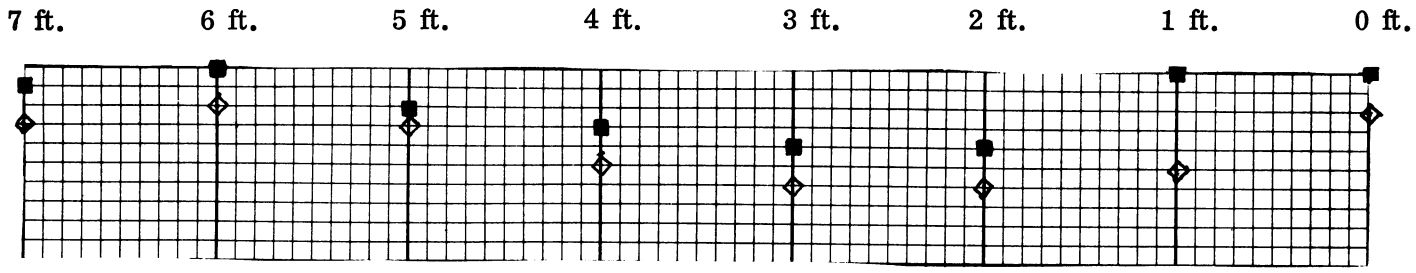
LEGEND

■ December 1971
◇ January 1973
1971 Traffic Volume

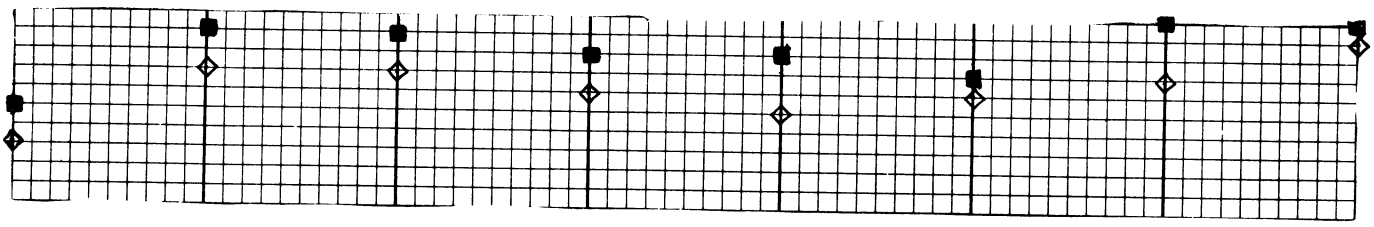
Measurements made across pavement —

0 represents right-hand edge stripe
Each horizontal increment = 1/32 inch
Each vertical increment = 1/10 foot

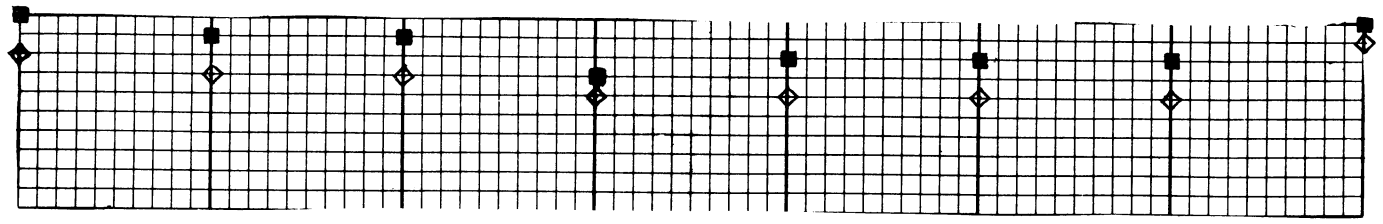
SITE 1 — BITUMINOUS CONCRETE — EBTL — Route 495 — East of Route 241
Built in November 1964 — AVD 75,640



SITE 2 — BITUMINOUS CONCRETE — EBTL — ½ Mile West of Route 1
Built in November 1964 — AVD 86,980



SITE 7 — PORTLAND CEMENT CONCRETE — EBTL East of Interstate 95
Built in November 1964 — AVD 79,760



SITE 8 — PORTLAND CEMENT CONCRETE — EBTL Just East of Route 613
Built in November 1964 — AVD 72,995

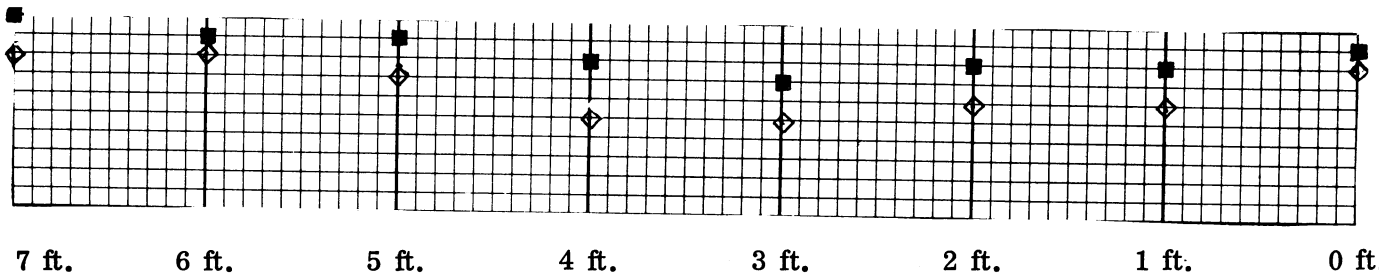
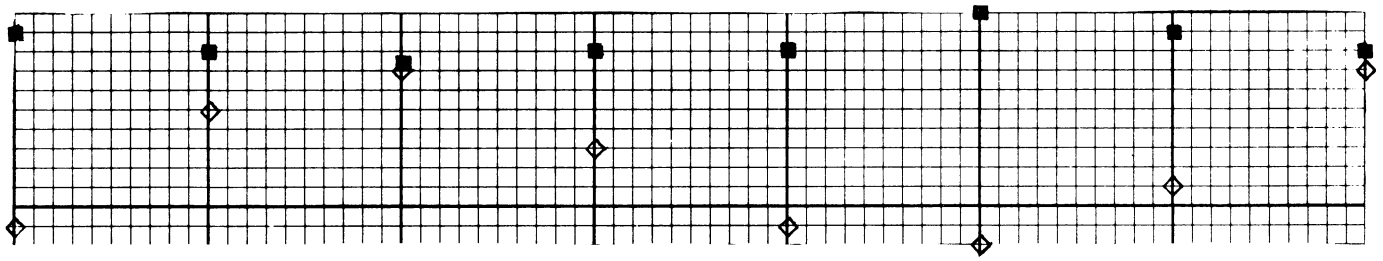


FIGURE 6

SITE 9 — BITUMINOUS CONCRETE — Bristol District — Washington County — NBTL — Route 11
0.2 Mile South of Route 895 to 0.6 Mile North of Route 1712
F-4 Placed 1964 — AVD 8,805

7 ft. 6 ft. 5 ft. 4 ft. 3 ft. 2 ft. 1 ft. 0 ft.



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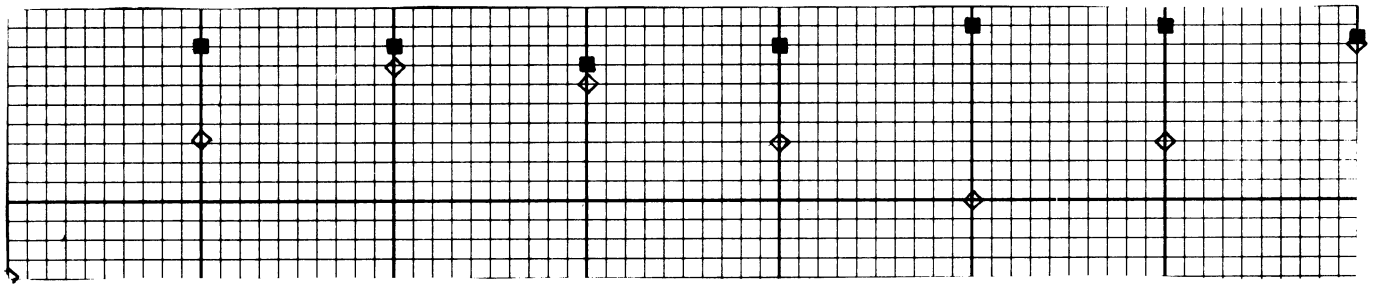
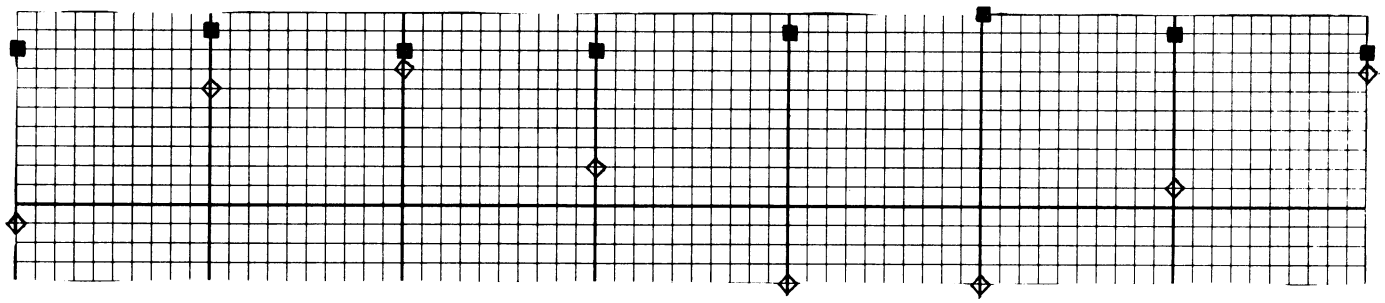


SITE 10 — BITUMINOUS CONCRETE — Salem District — Montgomery County — NBTL — Rt. 419
Intersection Route 1442 to 0.3 Mile East of Route 1424
I-3 Placed 1965 — AVD 14,605



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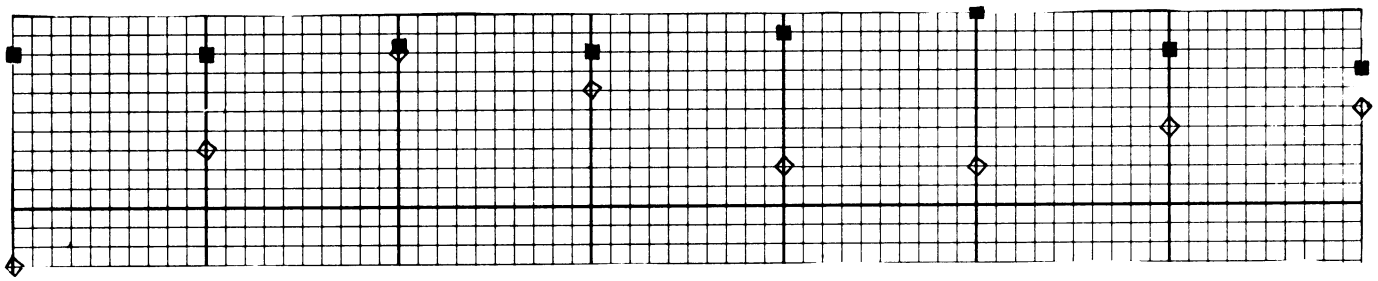
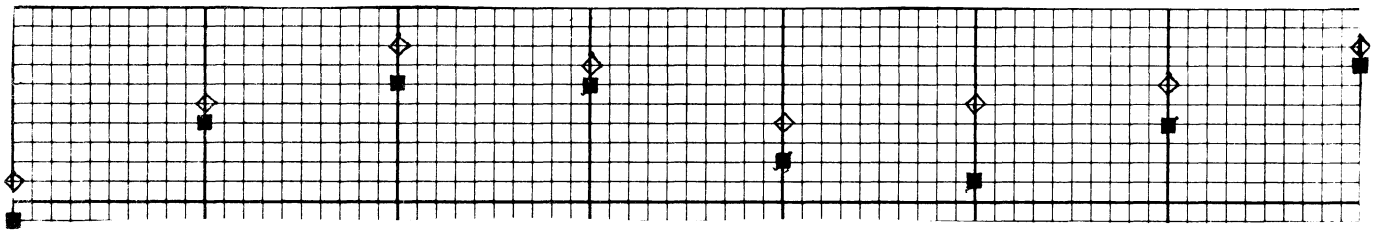


7 ft. 6 ft. 5 ft. 4 ft. 3 ft. 2 ft. 1 ft. 0 ft.

SITE 11 A — BITUMINOUS CONCRETE — Montgomery County — NBTL — Route 114
0.1 Mile North of Ammunition Plant to Rt. 659 North — H-2 Mix — AVD 7,750

7 ft. 6 ft. 5 ft. 4 ft. 3 ft. 2 ft. 1 ft.



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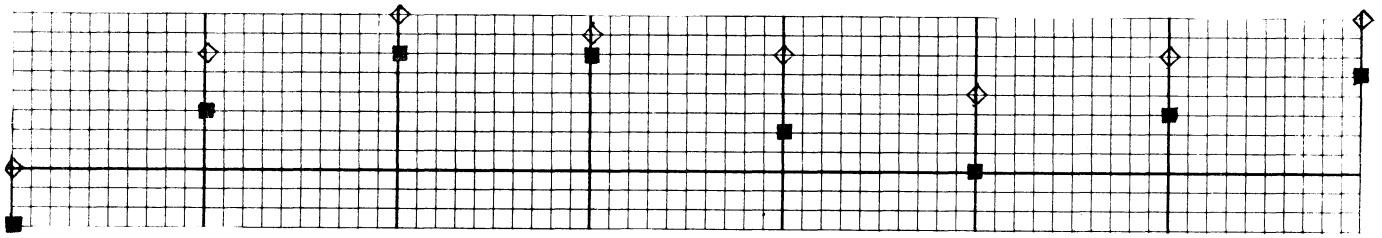
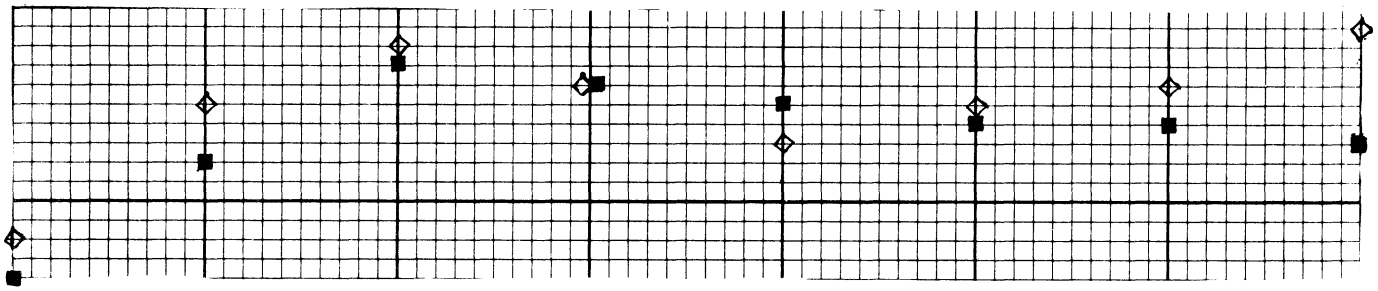


SITE 11 B — BITUMINOUS CONCRETE — Montgomery County — NBTL — Route 114
0.5 Mile South of Ammunition Plant to 0.1 Mile North of New River
I-2 Mix — AVD 7,750



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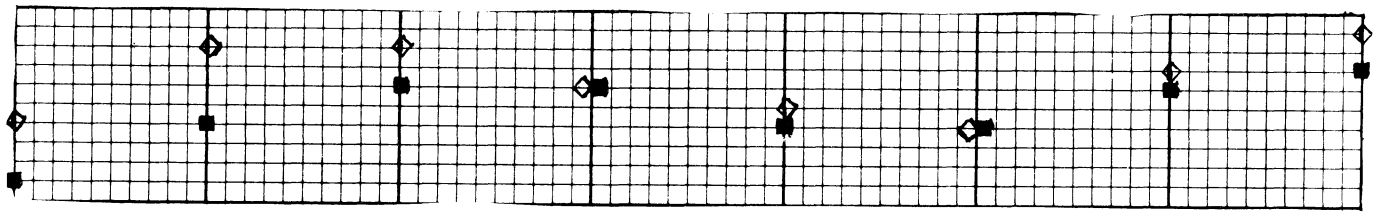
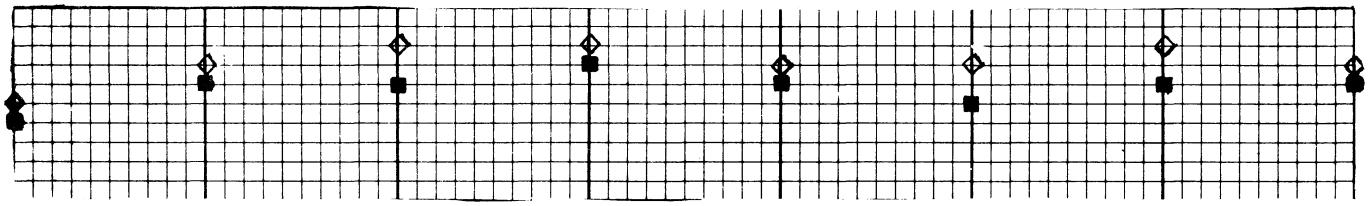


7 ft. 6 ft. 5 ft. 4 ft. 3 ft. 2 ft. 1 ft. 0 ft.

Figure 6 (cont.)

SITE 12 A — BITUMINOUS CONCRETE — Staunton District — NBTL — Route 11 in Verona
0.5 Mile South of Rt. 612 to Rt. 857 — H-2 and Deslicking Mix — Placed 1958

7 ft. 6 ft. 5 ft. 4 ft. 3 ft. 2 ft. 1 ft. 0 ft.



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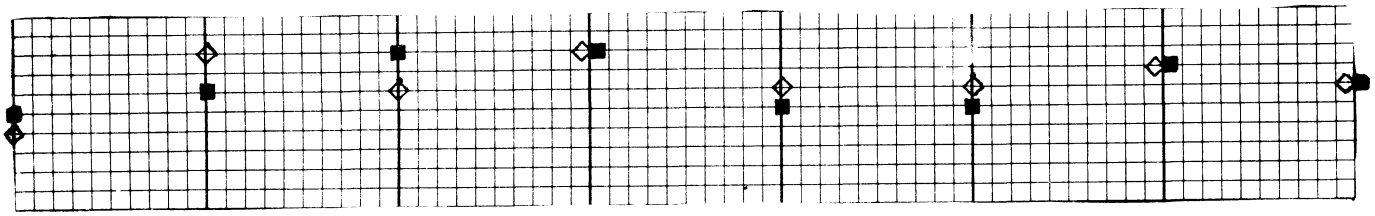
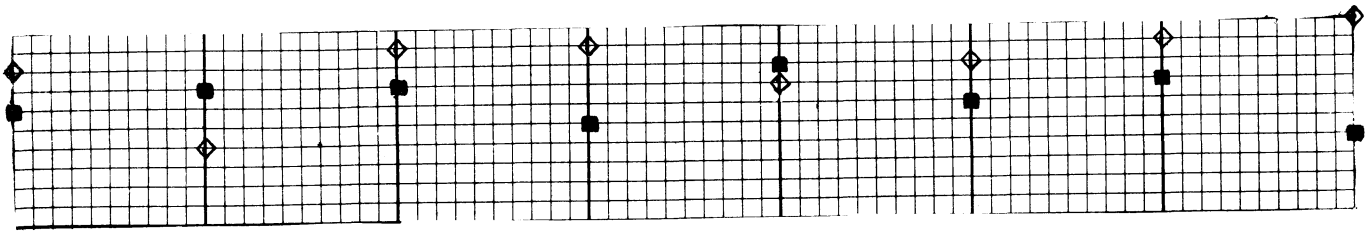
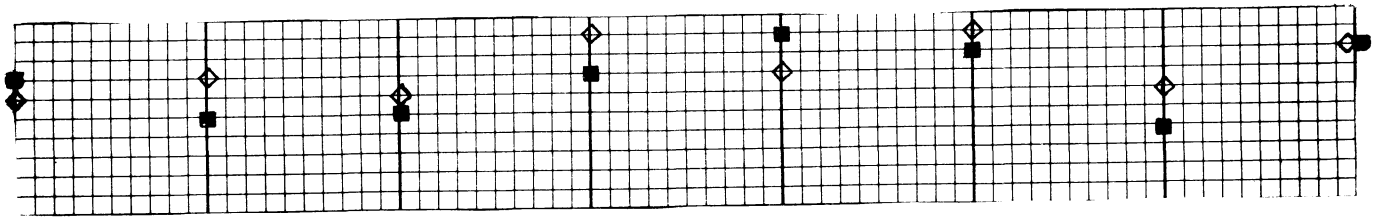


SITE 12 B — BITUMINOUS CONCRETE — Staunton District — NBTL — Route 11 in Verona
1.0 Mile South of Rt. 612 to 1.5 Mile South of Rt. 612 — MS-5 Mix — Placed 1970
AVD 5,000

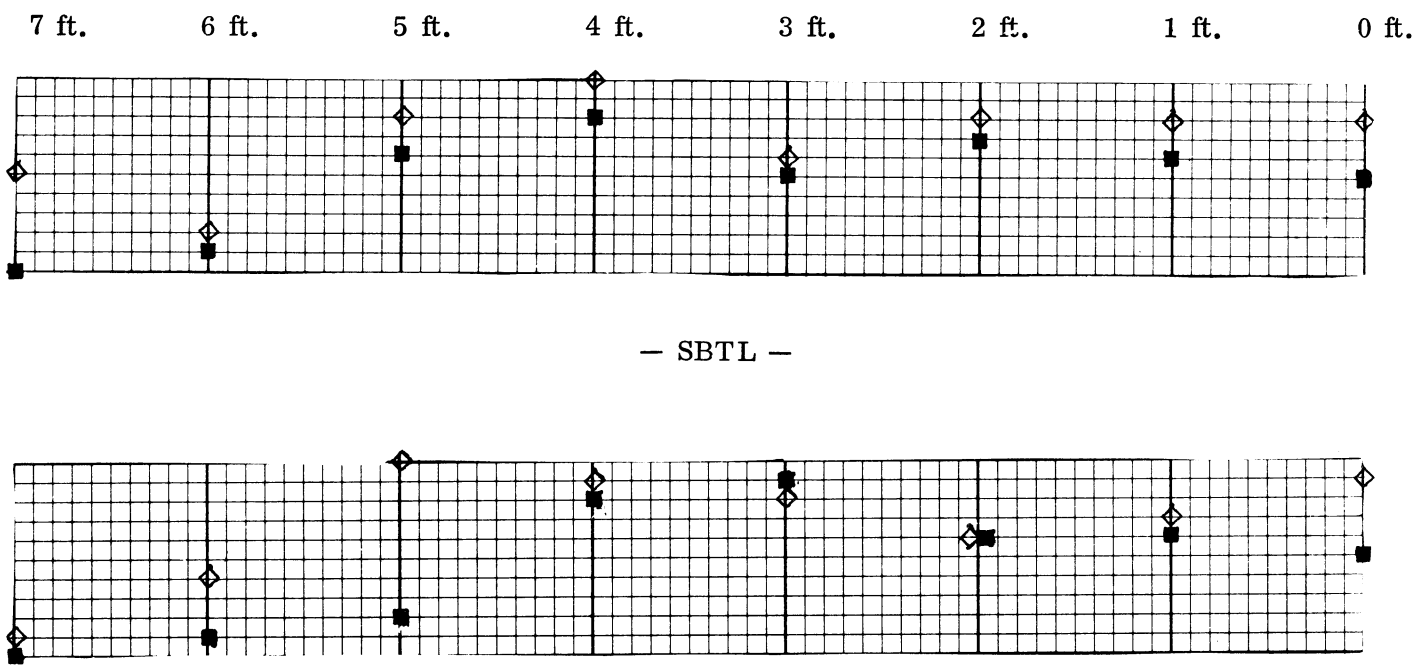


- SBTL -



7 ft. 6 ft. 5 ft. 4 ft. 3 ft. 2 ft. 1 ft. 0 ft.

SITE 12 C — BITUMINOUS CONCRETE — Staunton District — NBTL — Rt. 11 in Verona
0.2 Mile South of Rt. 275 — S-5 Mix — Placed in 1967 — AVD 5,000



SITE 13 — BITUMINOUS CONCRETE — Staunton District — Winchester — NBTL — Route 11
Intersection Route 649 to Intersection 652
MS-5 Placed 1971 — AVD 4,760

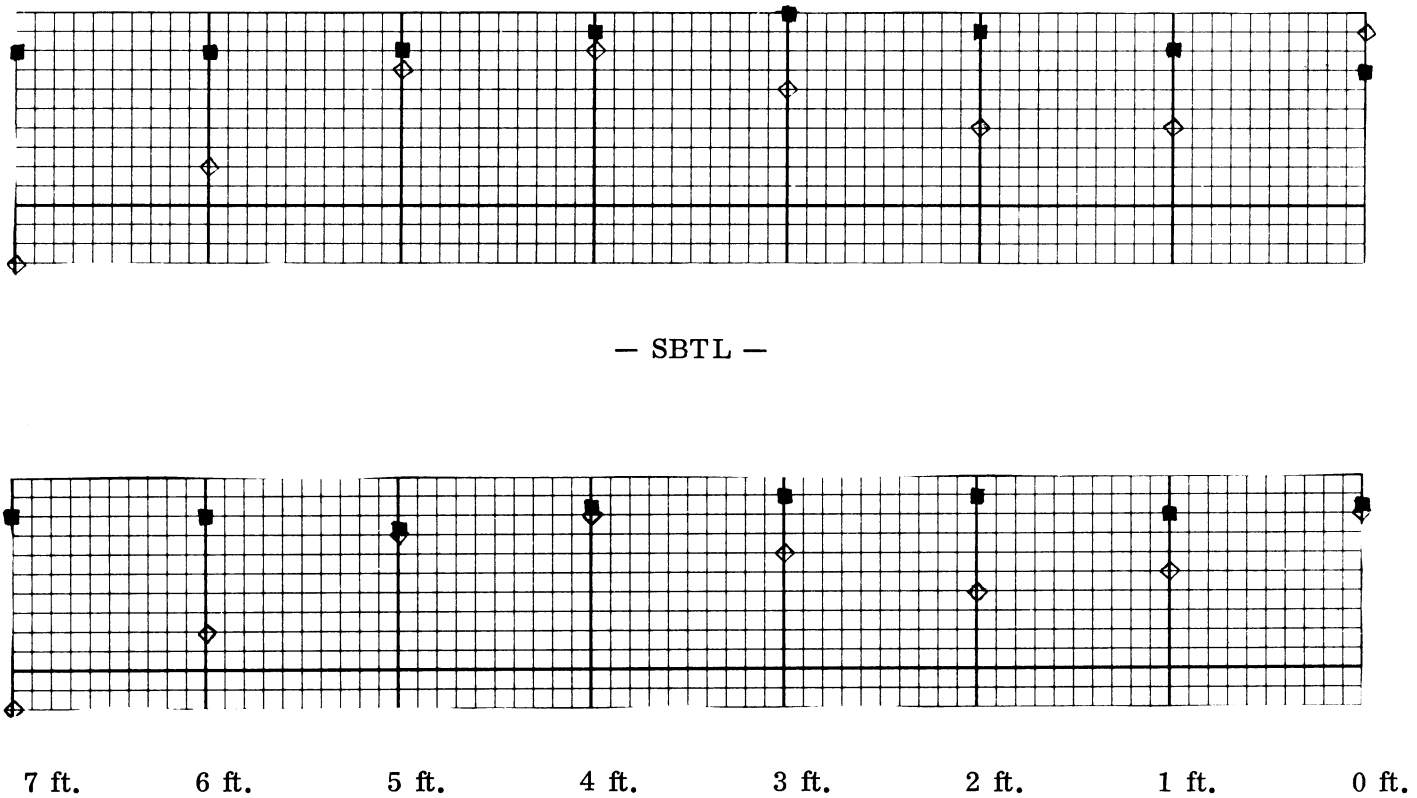
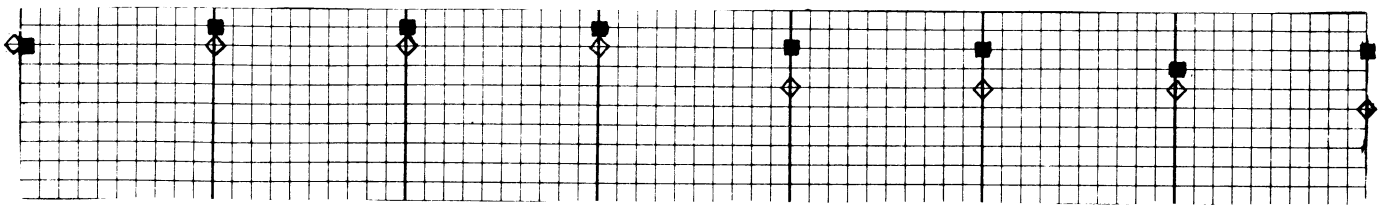


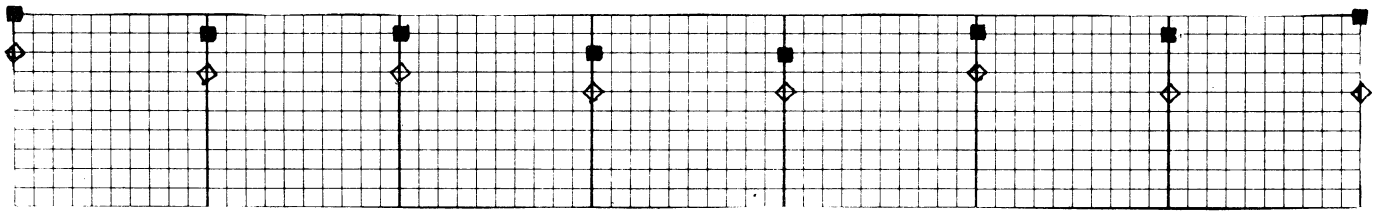
FIGURE 7

SITE 3 — PORTLAND CEMENT CONCRETE — Culpeper District
Alexandria Ramp to Rt. 1 North — Built in November 1964 — AVD 86,980

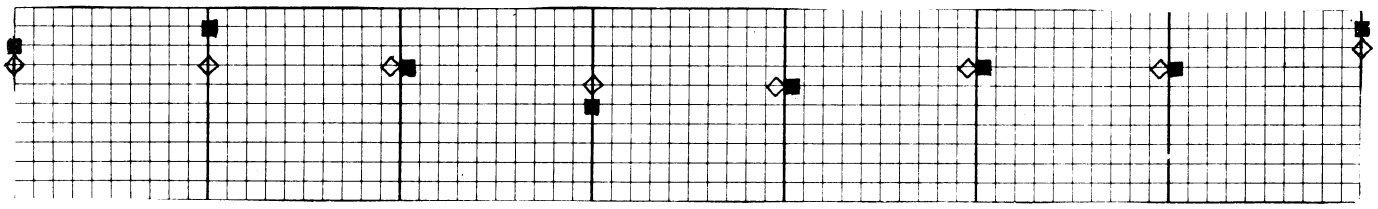
7 ft. 6 ft. 5 ft. 4 ft. 3 ft. 2 ft. 1 ft. 0 ft.



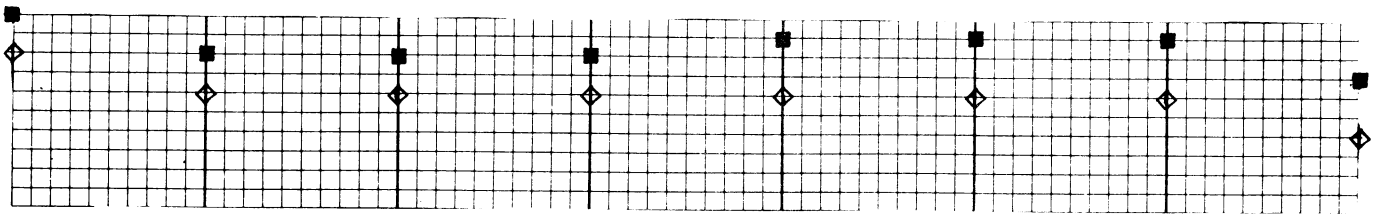
SITE 4 — PORTLAND CEMENT CONCRETE — Culpeper District
Richmond Ramp Leaving I-495 — Built in May 1966 — AVD97,430



SITE 5 — BITUMINOUS CONCRETE — Culpeper District
Ramp to Springfield Going South to I-95 — Built in May 1966 — AVD 97,430



SITE 6 — BITUMINOUS CONCRETE — Culpeper District
Ramp from Springfield to I-95 North Built in May 1966 — AVD 97,430



7 ft. 6 ft. 5 ft. 4 ft. 3 ft. 2 ft. 1 ft. 0 ft.

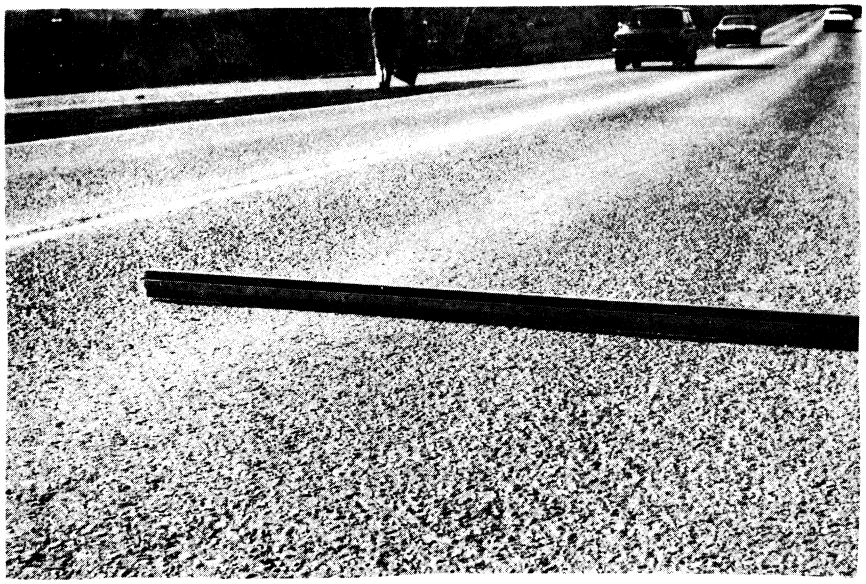


Figure 8. Limestone mix on Route 114, Montgomery County.

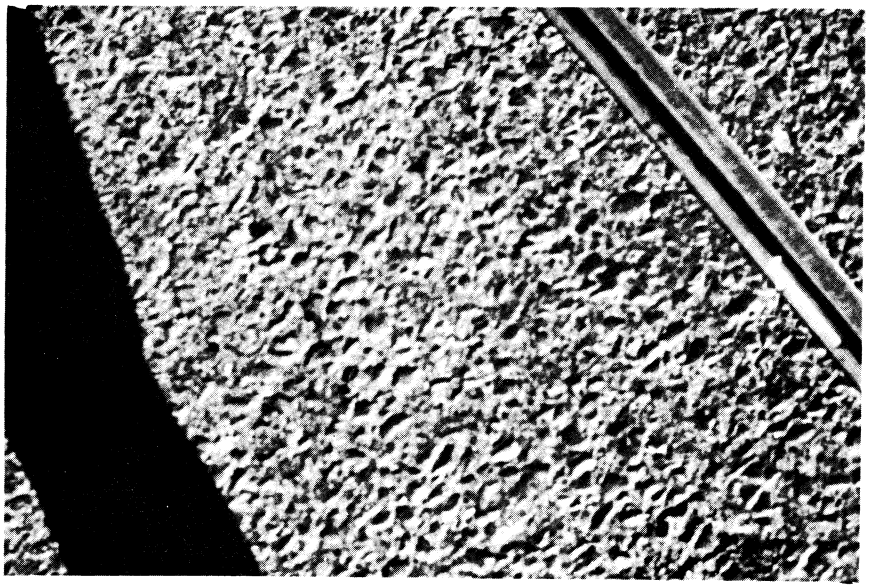


Figure 9. Close-up of mix in Figure 8

SUMMARY

This report presents the results from surveys of studded tire use and pavement wear measurements that have been conducted yearly in Northern Virginia since 1968 and in the Shenandoah Valley since 1972.

The percentages of studded tire usage for vehicles surveyed at the Pentagon increased from the beginning in 1968 until the second survey in December 1971 and dropped slightly in the 1973 survey. Also the percentage of usage for the Shenandoah Valley was slightly higher in 1972 than it was in 1973. It is believed that the drop in the usage of studded tires can be attributed in part to the mild winter of 1973.

From the pavement wear measurements in Northern Virginia, it was found that 1/32 to 3/32 inch wear has occurred three to four feet from the right-hand edge of the pavement. From the Shenandoah Valley measurements it was determined that 1/32 to 6/32 inch wear has occurred two to three feet from the right-hand edge of the pavement. From the wear measurements, it was found that more noticable wear has occurred in one year for the Shenandoah Valley area than in five years for the Northern Virginia survey. There is definite reason to believe that studded tires are contributing to the greater wear in the Valley area since the percentages of use for the first year range from 9.4% to 21% and some northern states are experiencing trouble with usage around 20%.

The high volumes of accumulated traffic using studded tires definitely damage the pavements with limestone mix surfaces more than those with concrete or other types of bituminous mix surfaces.

CONCLUSIONS

Although the studded tire surveys have been conducted for only two years in the Shenandoah Valley and five years in Northern Virginia, the writer feels that the following conclusions are valid:

1. The percentage of studded tire usage depends largely on the severity of the winter.

2. Certain types of roads, such as those with limestone mix surfaces, are affected more by studded tires than are other types of roads.

3. The major wear point on a road is dependent upon the type of road.

TABLE A-1

PERCENTAGE OF CARS EQUIPPED WITH STUDDED TIRES BY STATE

Location	Date	All States	Out-of-State	Virginia	Maryland	Wash. D. C.
Pentagon	Feb. 1969	2.3		2.8	3.0	0.5
	Feb. 1970	4.1		4.4	4.1	1.9
	Feb. 1971	7.7		6.9	7.4	5.3
	Dec. 1971	6.7		7.1	5.7	4.3
	Jan. 1973	6.1		7	5.0	2.0
Shenandoah	1972	15.3				
Valley	Jan. 1973	12.6	22.5	12.1		

TABLE A-2

PARKING LOT SURVEY FOR STUDDED TIRE USAGE

Location	Date	Snow Tread With Studs		Snow Tread Without Studs		Plain Tread With Studs		Plain Tread Without Studs	
		Front	Rear	Front	Rear	Front	Rear	Front	Rear
Pentagon	Feb. 1969	2(.03%)	103(2.3%)	21(.47%)	3173(71%)	0	0	4443(99.5%)	1170(26.2%)
	Feb. 1970	0	180(4.1%)	20(.5%)	3156(72.8%)	0	0	4317(99.5%)	999(23%)
	Feb. 1971	4(.1%)	350(7.7%)	13(.3%)	2986(61.1%)	0	0	4568(99.6%)	1245(27.2%)
	Dec. 1971	0	288(6.7%)	0	2103(48.7%)	0	0	4315(100%)	1924(44.6%)
	Jan. 1973	2(.04%)	268(6.1%)	77(1.76%)	2247(51.4%)	0	0	4295(98.2%	1859(42.5%)
Shenandoah Valley	Jan. 1973	3(.05%)	634(12.6%)	75(1.45%)	3453(68.5%)	0	0	4964(98.5%)	955(18.9%)

Figure A-1

WEAR MEASUREMENTS ON PAVEMENTS IN NORTHERN VIRGINIA

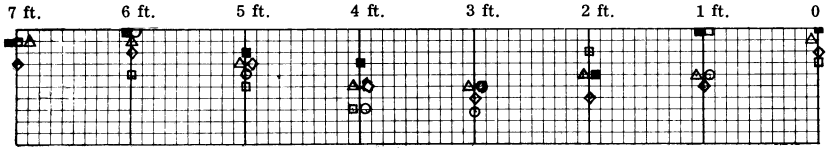
LEGEND

- ○ December 1968
- □ December 1969
- △ March 1971
- ■ December 1971
- ◇ January 1973

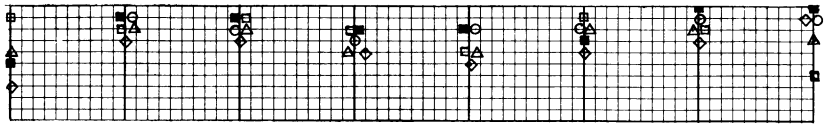
Measurements made across pavement —

O represents right-hand edge stripe
Each horizontal increment = 1/32 inch
Each vertical increment = 1/10 foot

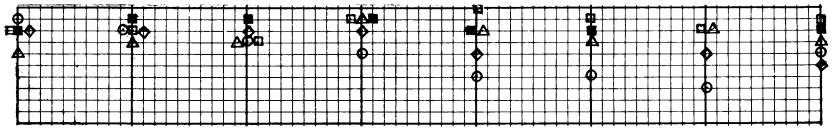
SITE 1 — BITUMINOUS CONCRETE — EBTL — Route 495 — East of Route 241
Built in November 1964 — 1971 AVD 75,640



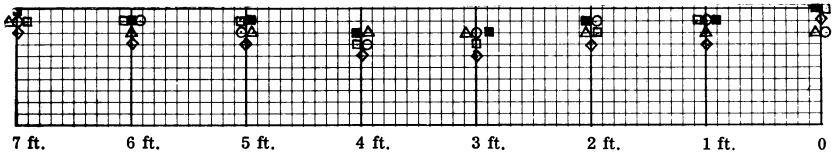
SITE 2 — BITUMINOUS CONCRETE — EBTL — ½ Mile West of Route 1
Built in November 1964 — 1971 AVD 86,980



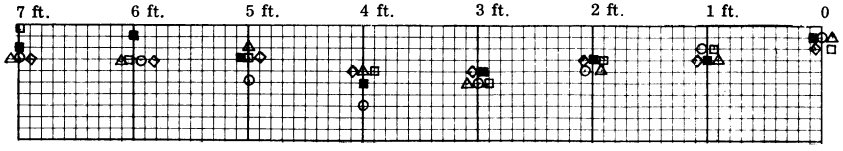
SITE 3 — PORTLAND CEMENT CONCRETE — Alexandria Ramp to Route 1 North
Built in November 1964



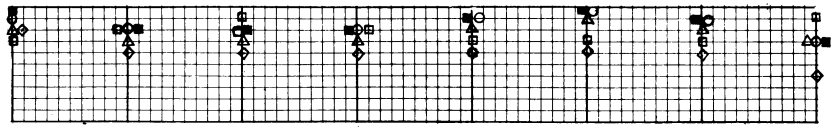
SITE 4 — PORTLAND CEMENT CONCRETE — Richmond Ramp Leaving Route 495
Built in May 1966



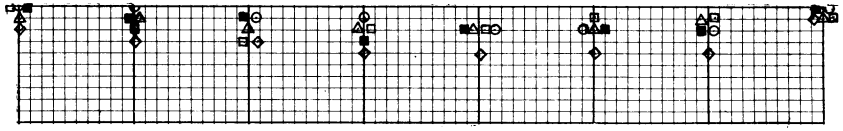
SITE 5 — BITUMINOUS CONCRETE — Ramp to Springfield Going South on Interstate 95
Built in May 1966



SITE 6 — BITUMINOUS CONCRETE — Ramp from Springfield to Interstate 95 North
Built in May 1966



SITE 7 — PORTLAND CEMENT CONCRETE — EBTL East of Interstate 95
Built in November 1964 — 1971 AVD 79,760



SITE 8 — PORTLAND CEMENT CONCRETE — EBTL Just East of Route 613
Built in November 1964 — 1971 AVD 72,995