NUCLEAR DENSITY EVALUATION ON ASPHALTIC CONCRETE

Final Report

by

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SYNOPSIS

This study was one of two studies designated as Research Project 62-1SB to evaluate the use of nuclear devices in highway construction. (1) The primary objective of this study was to evaluate a nuclear density device for obtaining densities on asphaltic concrete pavements during or after construction. On evaluating this device an attempt has been made to correlate nuclear density results with densities obtained from roadway cores taken at identical locations. Efforts were also made to determine the minimum thickness of an asphaltic concrete pavement in which nuclear density readings would not be affected by the underlying material.

Although the relationship between the percent of standard reading and the roadway densities showed a definite trend, results from 144 roadway cores and 170 nuclear readings indicated that the actual density at a given percent of standard could vary as much as 4 lbs/cu ft. Results also indicated that nuclear density readings were not affected by the underlying material when taking densities on slab thicknesses of 2 inches or more. On the basis of the inconsistency of the results obtained, it was decided to discontinue any additional testing as outlined in the proposal and to report the completed results.

As a future course of action, it is intended to continue accumulating nuclear density data on various state projects to eventually obtain an adequate statistical evaluation. However, this additional work will not be performed under Highway Planning and Research funds.

Number in parenthesis refer to list of references at the end of report.

INTRODUCTION

For many years highway departments throughout the country have been spending a great deal of time and money in obtaining roadway cores for density determinations. An ideal method of obtaining density for field control would be non-destructive testing. For this reason a study was initiated by the Louisiana Department of Highways in cooperation with the Bureau of Public Roads to evaluate the use of a nuclear density device for obtaining densities on asphaltic concrete pavement.

In obtaining nuclear density readings, gamma rays are allowed to penetrate the asphaltic concrete pavement which inturn bounce back and are picked up by the detector tubes. The more gamma rays picked up by the detector tubes the higher the count registered on the scaler. On very dense materials the gamma rays are absorped by the materials allowing less to bounce back and be picked up by the detector tubes. Therefore, a low count will result on the scaler. Based on this reasoning low densities give high counts and high densities give low counts.

The nuclear device used in this study was a Troxler model A-230 density gauge containing a small 2.0 millicurie radium 226 source in conjuction with a Troxler model 200 B type scaler.

The A-230 gauge is a non destructive backscatter device that contains six Geiger-Mueller detector tubes designed primarily for the measurement of density in the range from 80 to 160 pounds per cubic foot.

Figure 1 shows a photograph of both the A-230 density gauge and the model 200B scaler. The radium source is at the center of the gauge with two detector tubes at each of the triangular portions of the gauge. The measured area is primarily the area between the six detector tubes.

Figure 1 - Photograph of the A-230 Density Gauge and the Model 200B Scaler

SCOPE

This study was initiated as a research project, in cooperation with the Bureau of Public Roads, which consisted of two phases.

Phase I consisted of obtaining density results from roadway cores and attempting to correlate these results with nuclear density readings obtained at identical locations.

An effort was also made to determine the standard deviation in density that would occur when taking 26 consecutive readings at one designated area of roadway.

Phase II consisted of obtaining nuclear readings on seven Portland Cement concrete slabs in the laboratory, varying the thicknesses in order to determine at what thickness the underlying material would not affect the percent of standard readings of the nuclear device.

METHODOLOGY

Phase I

In an effort to correlate nuclear readings for density determinations, with densities as obtained by roadway cores, a number of separate test sections were constructed on state project 13-09-22, on La. U.S. 190 federal aid project F-128 (6). These test sections were constructed using 5-7-9-11-13 and 15 passes of the pneumatic roller at a contact pressure of 85 psi. Nuclear readings were taken on each of these test sections along with roadway cores for both the wearing and binder course lifts. The roadway cores were obtained directly beneath the nuclear density gauge in order to eliminate the possibility of a change in density from an adjacent area.

The roadway cores were tested for density by the bulk specific gravity method in accordance with LDH TR 304-66, "Determination of Specific Gravity of Compressed Bituminous Mixtures". Each test section was represented by an average of three roadway densities. Percent of standard readings were calculated for each section and the relationship between percent of standard and density was obtained. The percent of standard reading with the nuclear device was calculated by dividing the actual nuclear reading on the roadway by the standard reading taken on an aluminum standard plate.

An attempt was also made to determine the standard deviation of the density, as obtained by the nuclear device, thereby eliminating the variation that could occur when moving the instrument from one location to another. In doing so 26 consecutive readings were taken on a designated area of roadway. From these readings a percent of standard reading was calculated for each and the density was obtained from a calibration curve furnished by the Troxler Company. A standard deviation for density was then obtained.

Phase II

This phase consisted of obtaining readings with the nuclear device on seven Portland Cement concrete slabs made in the laboratory all having the same mix design and presumably the same density. These slabs were approximately 36 in. by 39 in. and varied in thickness from 1 in. to 3 in. The main objective for using Portland Cement concrete slabs rather than asphaltic concrete was to obtain a uniform density on each. Nuclear readings were obtained and percent of standard was calculated on each slab for thicknesses of 1-1 1/2 - 1 3/4 - 2 1/4 - 2 1/2 and 3 inches. Readings were taken for each slab on a wood floor covered with tile and also on a 2 inch piece of styrofoam for the purpose of determining at what thickness the underlying material would affect the percent of standard readings.

The data obtained was used to show the relationship of percent of standard versus concrete slab thickness in order to determine at what thickness a difference in percent of standard occurred.

Treatment of Data

Calibration curves were established in Phase I for wearing and binder courses showing the relationship between roadway core densities and percent of standard readings. These curves were established by introducing the data as shown in Tables 1 and 2 of the Appendix into a 1620 IBM computer using a Fortran programming system.

The data shown in Table 3 representing the standard deviation of the nuclear device at one location was calculated by standard statistical methods.

DISCUSSION OF RESULTS

Phase I

Tables 1 and 2 in the Appendix show the average results obtained for the wearing and binder course lifts respectively. The percent of standard results represent an average of three one minute counts just as the roadway densities are an average of three cores taken in the same areas as that measured by the nuclear device, namely the area between the detector tubes.

Figure 2, shows a comparison between the factory curve and the calibration curve obtained by nuclear readings and roadway densities on the wearing course mix. The calibration curve was obtained by the method of least squares. It is interesting to note that the calibrated curve is parallel to the factory curve, however, it is shifted approximately 8 lbs/cu ft. It is evident from the two curves that a calibration curve is a necessity when obtaining densities by the nuclear device. Nevertheless a calibration curve does not totally eliminate variation in density results.

Figure 3, shows the calibrated curve for the wearing course and its relationship to the individual results used to obtain the curve. As can be seen, even with a calibrated curve individual density results may vary as much as 4 lbs/cu ft. This is an excessive amount of variation for testing asphaltic concrete pavement.

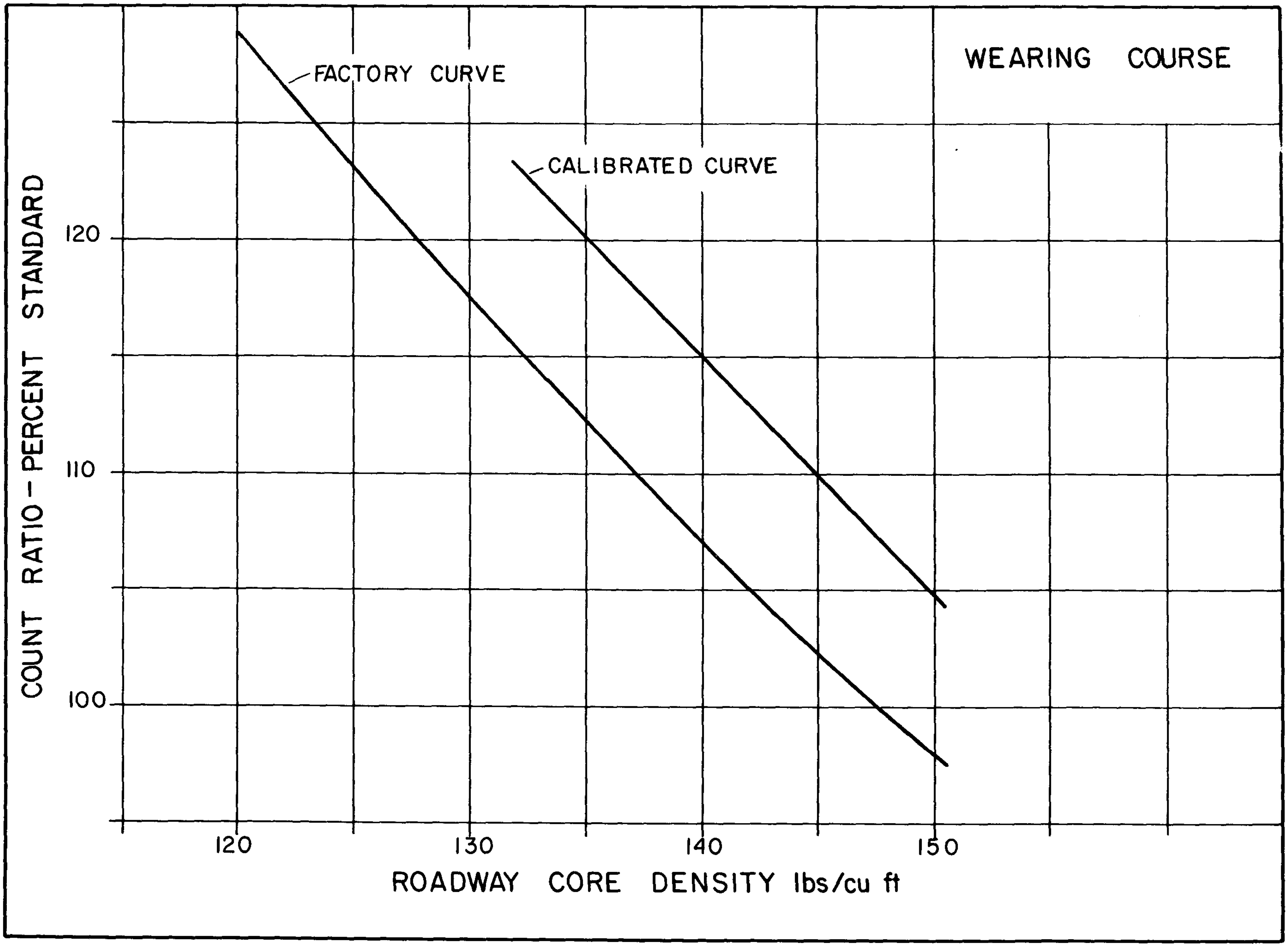


Figure 2 - Comparison of the Factory Curve and the Calibration Curve Obtained by Nuclear Readings and Roadway Densities for the Wearing Course Mix.

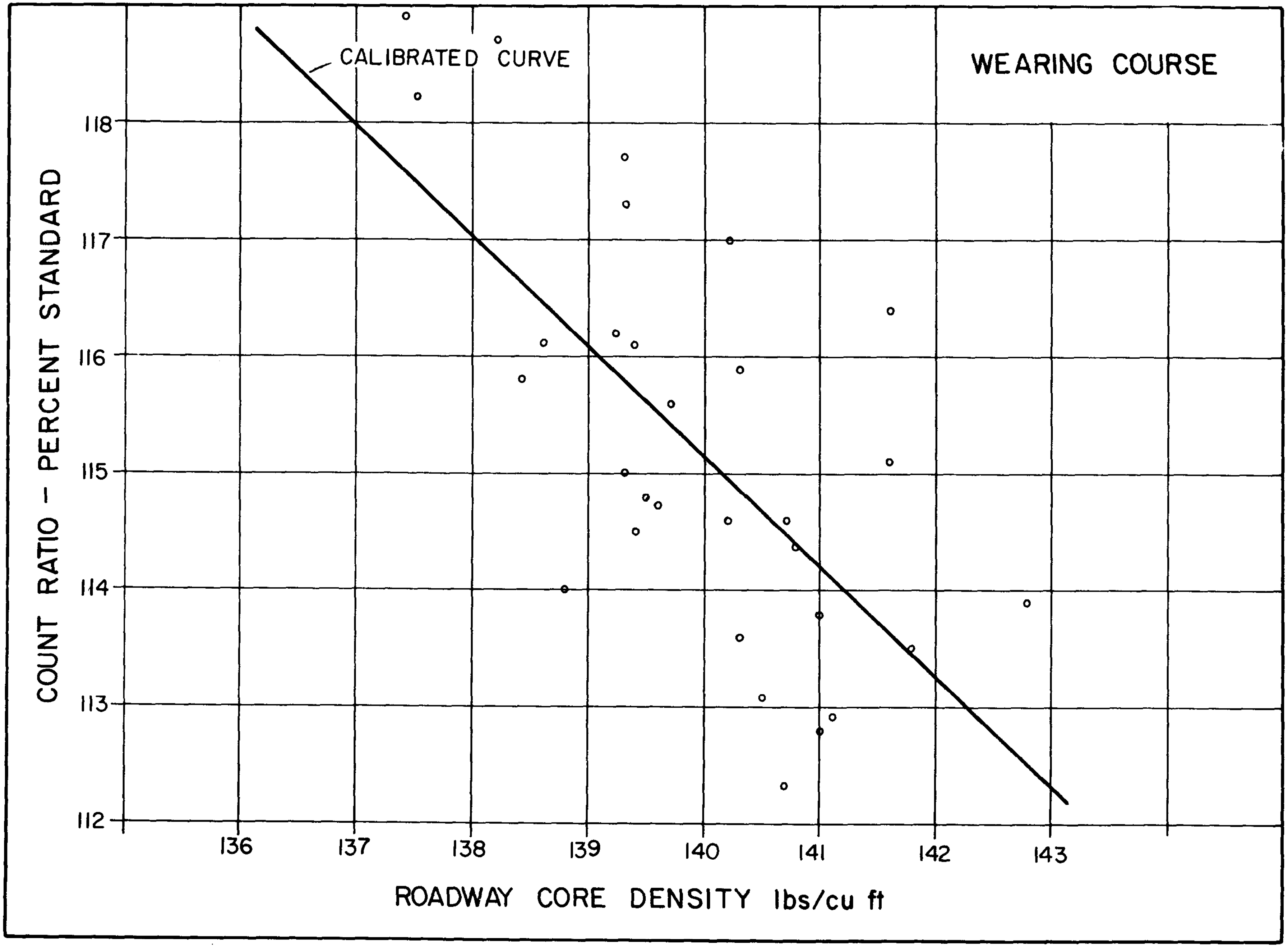


Figure 3 - The Relationship of the Individual Results and the Calibrated Curve for the Wearing Course Mix

Figure 4, represents a calibration curve obtained for the binder course lift using the data shown in Table 2 of the Appendix. It also shows a parallel relationship with the factory curve as did the wearing course curve, however, it shifted approximately 12 lbs/cu ft.

Because of the variation of the calibrated curves for wearing and binder course in relation to each other, and in addition to the variation in relation to the factory curve, it appears that a calibration curve would have to be established for each separate project or when a considerable change in material or gradation is encountered. The composite gradation for the wearing and binder course lifts are shown in Table 6 of the Appendix.

Figure 5, shows the calibrated curve for the binder course and its relationship to the individual results used to obtain the curve. As is indicated, the variation in density of the individual results is approximately 2 lbs/cu ft. which is less than the variation obtained on the wearing course.

The data obtained on both the wearing and binder course does show a definite trend even though the range is quite wide. Although it appears that accurate density results cannot consistently be obtained by the nuclear device, it may be possible that the nuclear device is accurate enough to determine when maximum density is obtained during the pneumatic rolling procedure.

On investigating this possibility curves were established for both the wearing and binder courses using the data from Tables 1 and 2 of the Appendix. Nuclear readings were taken on 30 wearing course sections and 18 binder course sections along with roadway cores. The number of passes were varied for each section to determine at what compactive effort maximum density would be obtained. The temperature of which pneumatic rolling began was held constant at approximately 200°F and was measured by means of thermocouples.

Figures 9 through 13 of the Appendix represent the percent of standard reading with the nuclear device, and the roadway cores densities versus the number of passes of the pneumatic roller for the wearing course. It is interesting to note that in each of the figures, with the exception of Figure 9, the number of passes that gave the lowest percent standard value also gave the highest roadway core density. Following each of the plotted points separately when the percent standard decreased the density at that same number of passes increased. Although the points on the density curve are connected by straight lines, it is not intended to mean that the densities were taken at the same location. The odd pattern of the density curves is simply because each plotted point (number of passes) represent a separate test section which possibly had resulted in some variations in the mix. The individual points were connected by straight lines merely to emphasize the results obtained by the nuclear device.

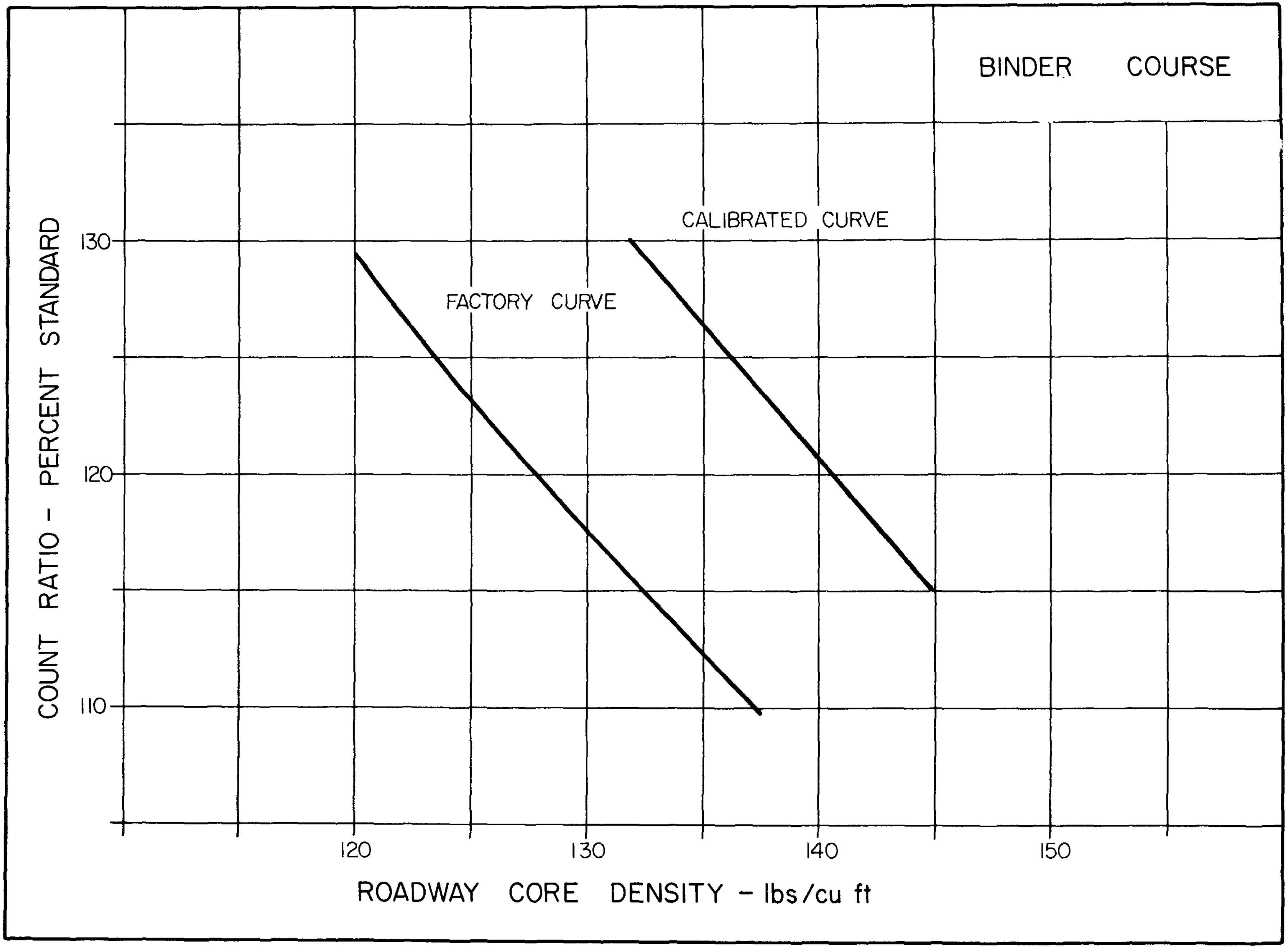


Figure 4 - Comparison of the Factory Curve and the Calibration Curve Obtained by Nuclear Readings and Roadway Densities for the Binder Course Mix

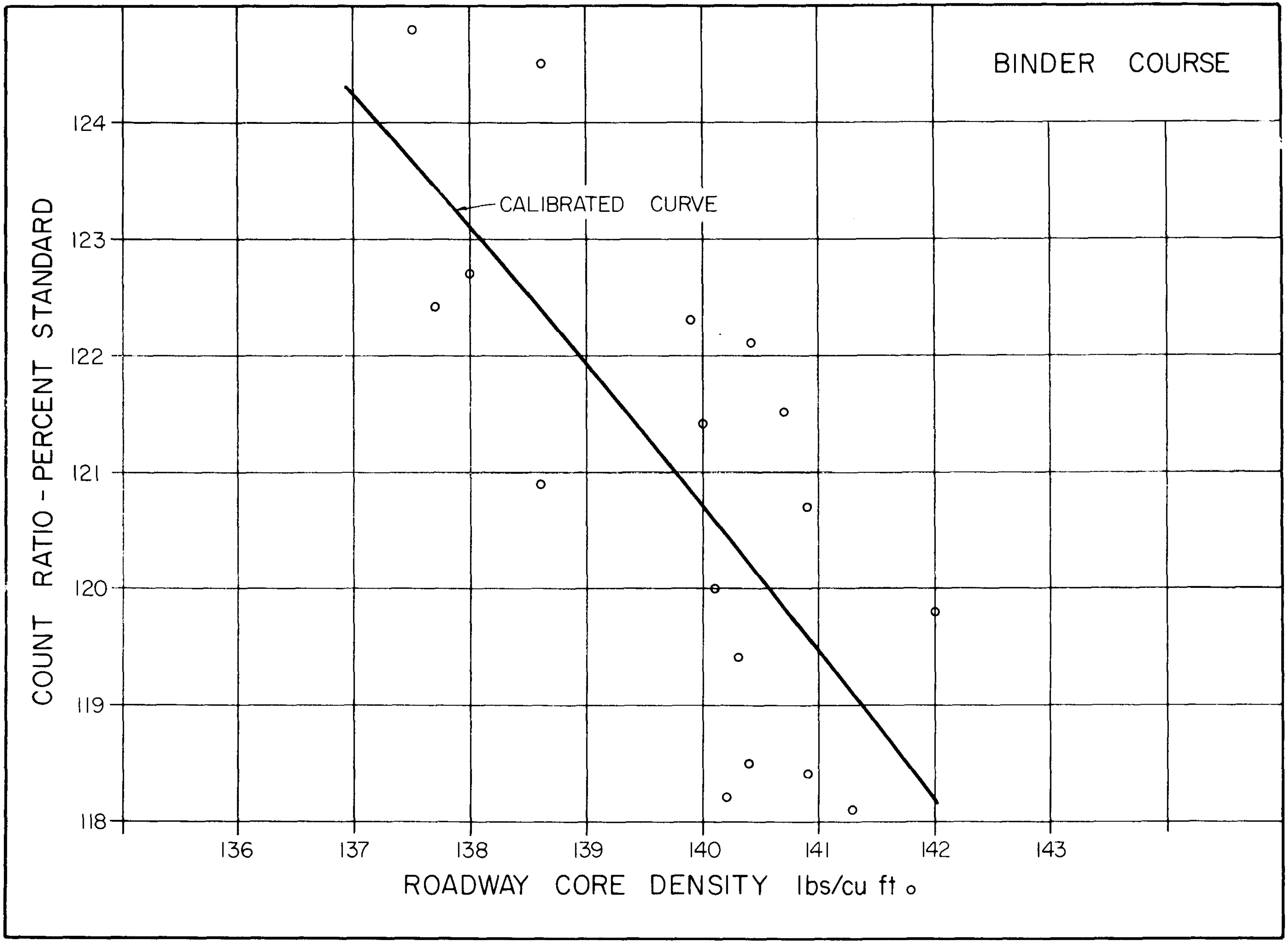


Figure 5 - The Relationship of the Individual Results and the Calibrated Curve for the Binder Course Mix

Figures 14 through 16 of the Appendix represent similar relationships for the binder course mix. As mentioned for the wearing course, the binder course also showed that the compactive effort needed to obtain maximum density could be determined by the nuclear device during compaction.

With only a few exceptions in each of the curves for wearing and binder course lifts, the nuclear readings did determine whether or not the density would increase or decrease from one section to another. It should be noted, however, that where exceptions occurred the actual density was usually less than 1 lb/cu ft. difference. For example, in Figure 16 contrary to expectations, the curve at the top of the page shows that the percent standard increased from 13 to 15 passes, indicating that the roadway core density should decrease. However, the curve on the bottom of the page shows otherwise. This increase of density was only 0.7 lbs/cu ft. which could possibly be due to the deviation in the nuclear readings.

Standard Deviations for Nuclear Densties

In order to determine the magnitude of variation that could be expected from the nuclear device, 26 readings were taken at the same location without moving the instrument. From these readings percent standards were obtained and the standard deviation for percent standard and for density was obtained as based on the factory curve. The factory curve was used as a basis because the data had been obtained on a project other than the project previously mentioned and enough data was not available to calculate a calibration curve. However, assuming the calibration curve would be parallel to the factory curve, the same results would be obtained. The results shown in Table 3 of the Appendix indicate that the percent standard reading had a standard deviation of 0.27 percent and due to the proportional relationship with density as shown by the factory curve the density has a standard deviation of 0.27 lbs/cu ft.

Eliminating all the other variables that may occur when operating the nuclear device and concentrating on the standard deviation that occurs when taking a number of readings at the same location, a normal distribution curve for density was obtained, as shown in Figure 6. As mentioned previously, the data for the normal distribution curve is based on the factory curve. As indicated by the Figure, 68 percent of the densities measured at the same location with the nuclear device will be within ± 0.27 lbs/cu ft., where 95 percent of the sample will be within ± 0.54 lbs/cu ft. and 100 percent of the samples will fall within ± 0.81 lbs/cu ft. As can be seen, for 100 percent accuracy the range for density would be 1.62 lbs/cu ft. which could very well be enough variation to fail a density on the roadway. Also remember this variation does not take into consideration other variables such as the thickness of the material being tested, the underlying base material along with the variation of the gradation. These variables could account for much larger variations than that shown in Figure 6. This is

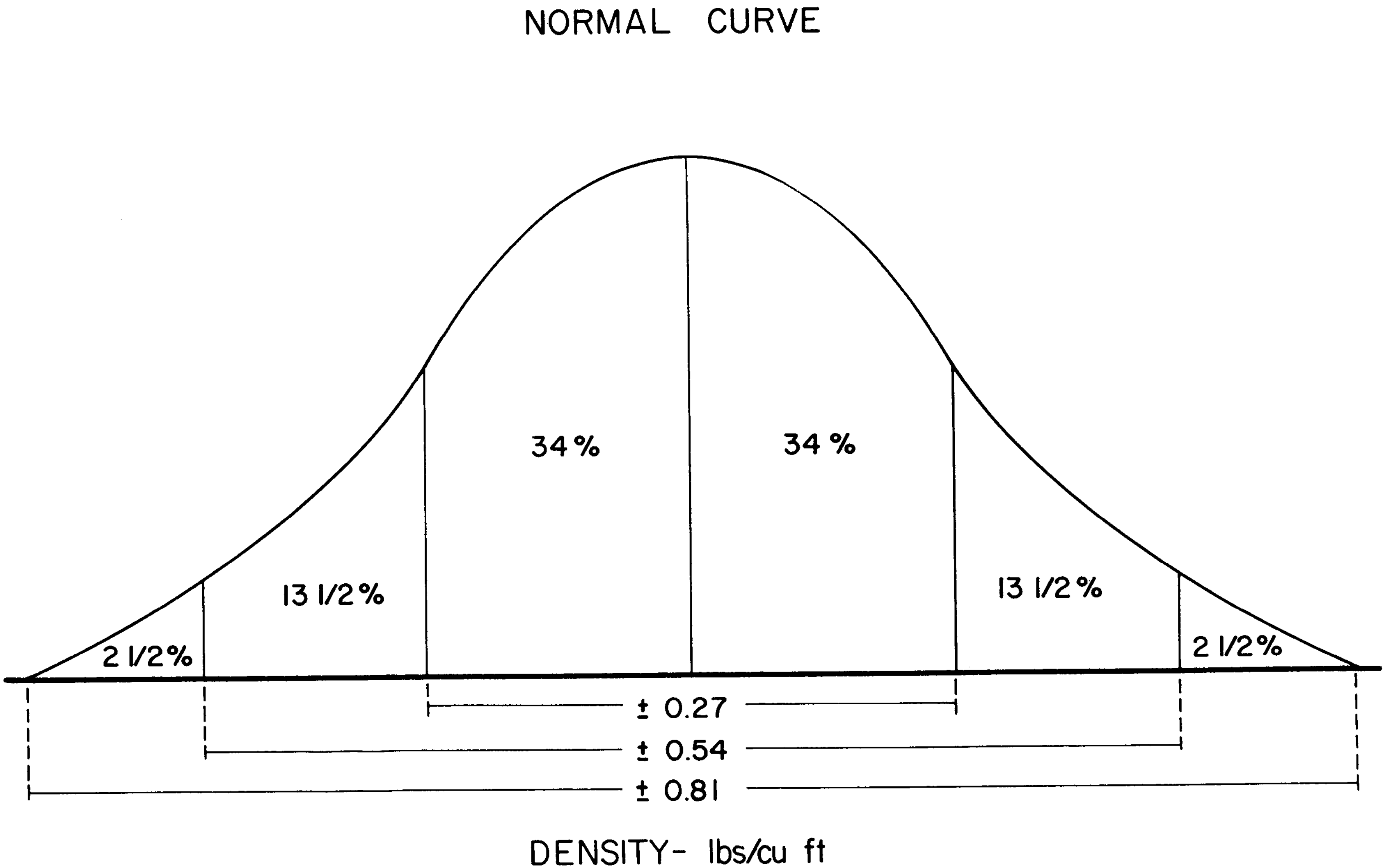


Figure 6 - Normal Distribution Curve for Density When Comparing Nuclear Readings Obtained From One Test Location with Densities from the Factory Curve

probably the reason why the percent standard in Figure 16 showed an increase from 13 to 15 passes even though the roadway core density also showed an increase.

Phase II

Variability in the thickness of the asphaltic concrete pavement could very well affect the density results obtained by the nuclear device. In order to investigate the relationship between thickness and density seven Portland Cement concrete slabs were molded. The slabs were approximately 36 inches by 39 inches in dimension and varied from 1 to 3 inches in thickness. The mix design for each of the slabs was the same and the density on each was assumed to be fairly constant. The main reason for using concrete was to obtain a constant density on each slab whereas, with asphaltic concrete this would have been very difficult to achieve.

It was anticipated, that by taking nuclear readings on each of the slabs, when placed directly on a tile floor, and compared with readings of the same slabs when placed on a large sheet of styrofoam, 2 inches thick, detection could be made as to what thickness would be affected by the underlying material. Figure 7 shows a photograph of the nuclear device with respect to one of the concrete slabs on the 2 inch thick styrofoam. Table 4 lists the nuclear readings and percent standard on each of the slabs.

Figure 8, represents the relationship between concrete slab thickness and percent standard reading. It appears from the figure that for a thickness of 2 inches plus, the percent standard is relatively the same indicating comparable densities. Below 2 inches the curves began to separate indicating that the nuclear readings are being affected by the underlying material which in this case is styrofoam.

Although the curves in Figure 8 clearly indicate a separation beginning at the 2-inch slab, it was not expected that as the thickness increased the percent standard would increase. Theoretically, assuming the 3-inch slab is at the same density as the 2-inch slab, the percent standard should rise vertically at nearly the same percent standard indicating approximately the same density. As was mentioned previously, as the percent standard increased the density decreased. Therefore the reason for an increase of percent standard on the 3-inch slab cannot be explained. It is reasonable to believe that due to the fact that the nuclear device is a backscatter device the height of the slab from the floor may have some affect on the readings even though the concrete slabs were believed to be large enough in area to escape this problem.

Table 5 of the Appendix gives the results for nuclear readings on the tile floor and the styroform alone. As is expected the styrofoam readings gives a percent

Figure 7 - Photograph of the Nuclear Device Testing a Concrete Slab Overlaying a 2 Inch Piece of Styrofoam

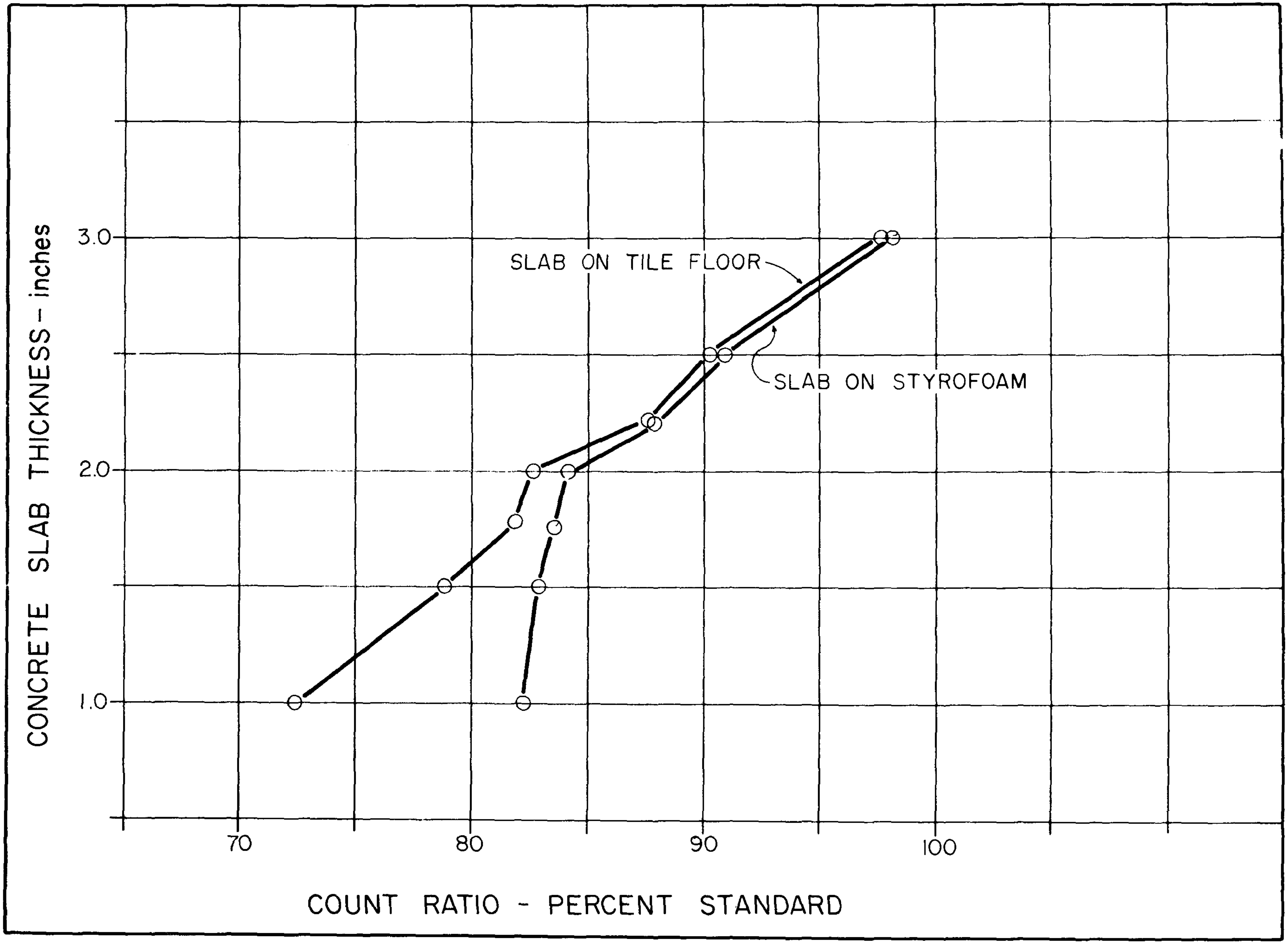


Figure 8 - Relationship Between the Concrete Slab Thickness and the Percent of Standard Reading

standard of 130.6 as compared to 88.7 for the tile floor readings, which again shows that the highest density gives the lowest percent of standard.

CONCLUSIONS

(1) When comparing the percent standard from the nuclear readings with its corresponding roadway core density, the density varied as much as 4 lbs/cu ft. at a given percent of standard. This is excessive for testing purposes.

(2) When taking 26 one-minute counts at the same location without moving the instrument the calculated standard deviation for density as based on the factory curve was ± 0.27 lbs/cu ft.

(3) The normal distribution curve showed that when taking continous reading at the same location, 68 percent of the densities will fall within ± 0.27 lbs/cu ft., 95 percent of the densities will fall within ± 0.54 lbs/cu ft. and 100 percent of the densities will fall within ± 0.81 lbs/cu ft. For 100 percent accuracy the density would range 1.62 lbs/cu ft. With other variables, such as, moving the instrument, change in gradation of the material, change in thickness of the material being tested as well as differences in the underlying base material, the range in density should be higher.

(4) Calibration curves should be obtained for each separate project and for each different course, such as, wearing or binder courses for which the gradation differs considerably.

(5) Indications are that the nuclear device may be used to determine the number of passes with the pneumatic roller that will give maximum density, as long as the change in densities for one given number of passes to another are greater than 1.6 lbs/cu ft. Otherwise the range for 100 percent accuracy of 1.6 lbs/cu ft. may occur and be somewhat misleading.

(6) When taking nuclear readings on concrete slabs it appears that as long as the slab is 2 inches or greater the densities or percent standard will not be affected by the underlying material. It can only be assumed that the asphaltic concrete pavements will give the same results.

(7) It is believed that with the known variations in nuclear readings discussed in this study combined with the unknown variables that occur on the roadway and in the nuclear device itself, it is not possible at this time to use the nuclear density device for accurately determining densities on asphaltic concrete pavements.

RECOMMENDATIONS

It is intended to continue accumulating data on asphaltic concrete pavements with the nuclear device, in order to obtain an adequate statistical evaluation. This additional work will be done at the expense of the Department excluding Highway Planning and Research funds.

It is recommended that future studies be undertaken to obtain hot mix roadway densities by nuclear means, with an effort to determine whether or not the accuracy of the device in relation to density will justify the cost for non destructive testing.

BIBLIOGRAPHY

(1) C. M. Higgins, J. E. Scotto, Jr. "Nuclear Moisture-Density Evaluation", Louisiana Department of Highways Research Report No. 22, June 1966.

APPENDIX

TABLE 1

COMPARATIVE CONSTRUCTION DATA IMMEDIATELY AFTER COMPLETION RELATING PERCENT OF STANDARD BY MEANS OF THE NUCLEAR DEVICE WITH DENSITY AS OBTAINED FROM ROADWAY CORES

Wearing Course

Test Section	Number of Passes with Pneumatic Roller	% Standard Reading with Nuclear Device	Density Lbs/cu. ft. from Roadway Cores
A	5	114.4	140.8
	7	116.2	139.2
	9	112.9	141.1
	11	113.5	141.8
	13	112.8	141.0
	15	114.6	140.7
B	5	117.3	139.3
	7	115.6	139.7
	9	118.7	138.2
	11	116.1	138.6
	13	116.1	139.4
	15	113.8	141.0
C	5	117.7	139.3
	7	116.4	141.6
	9	117.0	140.2
	11	115.1	141.6
	13	113.9	142.8
	15	115.9	140.3
D	5	118.2	137.5
	7	118.9	137.4
	9	115.0	139.3
	11	115.8	138.4
	13	114.8	139.5
	15	113.1	140.5
E	5	112.3	140.7
	7	114.0	138.8
	9	114.6	140.2
	11	113.6	140.3
	13	114.7	139.6
	15	114.5	139.4

TABLE 2

COMPARATIVE CONSTRUCTION DATA IMMEDIATELY AFTER COMPLETION RELATING PERCENT OF STANDARD BY MEANS OF THE NUCLEAR DEVICE WITH DENSITY AS OBTAINED FROM ROADWAY CORES

Binder Course

Test Section	Number of Passes with Pneumatic Roller	% Standard Reading with Nuclear Device	Density Lbs/cu.ft. from Roadway Cores
A	5	124.8	137.5
	7	119.8	142.0
	9	122.1	140.4
	11	121.5	140.7
	13	122.3	139.9
	15	124.5	138.6
B	5	118.5	140.4
	7	119.4	140.3
	9	122.7	138.0
	11	120.9	138.6
	13	118.4	140.9
	15	121.4	140.0
C	5	120.0	140.1
	7	117.4	141.8
	9	122.4	137.7
	11	118.1	141.3
	13	118.2	140.2
	15	120.7	140.9

TABLE 3

STANDARD DEVIATION OF PERCENT OF STANDARD AND DENSITY WHEN LOCATED AT THE SAME TEST POSITION

Standard Reading	Test Position 1 Test	%Standard	Deviation from average %Standard	Density from factory curve	Deviation from average density lbs/cu. ft
68975	80101	116.1	+0.7	138.9	-0.7
	80005	116.0	+0.6	139.0	-0.6
	79628	115.4	0	139.6	0
	79599	115.4	0	139.6	0
	79618	115.4	0	139.6	0
	79405	115.1	-0.3	139.9	+0.3
	79379	115.1	-0.3	139.9	+0.3
	79660	115.5	+0.1	139.5	-0.1
	79698	115.4	0	139.6	0
	79268	114.9	-0.5	140.1	+0.5
	79546	115.3	-0.1	139.7	+0.1
	79859	115.8	+0.4	139.2	-0.4
	79566	115.4	0	139.6	0
	79692	115.5	+0.1	139.5	-0.1
	79600	115.4	0	139.6	0
	79594	115.4	0	139.6	0
	79791	115.7	+0.3	139.3	-0.3
	79644	115.5	+0.1	139.5	-0.1
	79518	115.3	-0.1	139.7	+0.1
	79859	115.5	+0.1	139.5	-0.1
	79629	115.2	-0.2	139.9	+0.2
69146	79853	115.5	+0.1	139.5	-0.1
	79879	115.5	+0.1	139.5	-0.1
	79614	115.1	-0.3	139.9	+0.3
	79698	115.3	-0.1	139.7	+0.1
	79558	115.1	-0.3	139.9	+0.3

Average % Standard = 115.4
Standard Deviation = ±0.27 percent

Average Density from Calibration Curve - 139.6
Standard Deviation - ±0.27 Lbs/cu. ft.

TABLE 4

TEST RESULTS ON CONCRETE SLABS TO DETERMINE THE AFFECT OF THE UNDERLYING MATERIAL ON THE NUCLEAR READINGS

Slab Thickness	Standard Count	Actual Count	Percent of Standard		Standard Count	Actual Count	Percent of Standard
	Styrofoam					Tile Floor	
1"	64945	53051			64919	46936	
	65294	53620			64549	46708	
	64576	53512			64958	46949	
	65089	53694			64660	46859	
	64825	53340			64424	47091	
Total	324729	267217	82.3%	Total	323510	234539	72.5%
1.5"	65899	54431			66186	51957	
	65877	54582			66175	52535	
	65467	54384			66126	52164	
	65761	54761			66434	52209	
	65608	54351			66104	52376	
Total	328612	272509	82.9%	Total	331025	261241	78.9%
1.75"	66296	54377			65603	55147	
	66301	54601			65792	55270	
	66339	53953			66255	54987	
	66214	54287			65529	55057	
	66051	54132			66167	54974	
Total	331201	271350	81.9%	Total	329346	275435	83.6%
2.0"	66357	56162			66010	54880	
	66943	55881			66244	54852	
	66720	56484			66295	54825	
	66805	55865			66310	54652	
	66356	55997			66558	54573	
Total	333181	280389	84.2%	Total	331417	273782	82.6%

TABLE 4 (CONTINUED)

TEST RESULTS ON CONCRETE SLABS TO DETERMINE THE AFFECT OF THE UNDERLYING MATERIAL ON THE NUCLEAR READINGS

Slab Thickness		Standard Count	Actual Count	Percent of Standard		Standard Count	Actual Count	Percent of Standard
		Styrofoam				Tile Floor		
2.25"		66474	58743			66751	58515	
		66878	58803			66326	57995	
		66889	58735			66183	58246	
		66439	58821			66434	58623	
		66835	58927			66159	58115	
	Total	333515	294029	88.2%	Total	331853	291494	87.8%
2.5"		66626	60475			67001	60369	
		66821	60912			66901	60403	
		66452	60503			66740	60435	
		66182	60447			66982	60583	
		66775	60577			66989	60583	
	Total	332856	302914	91.0%	Total	334613	302373	90.4%
3.0		66408	65576			67305	65579	
		66677	65377			66939	65678	
		67071	65325			67065	65692	
		66890	65708			67545	65566	
		66569	65414			67389	65845	
	Total	333615	327400	98.1%	Total	336243	328360	97.7%

TABLE 5

NUCLEAR READINGS OF THE TILE FLOOR AND THE 2" THICK STYROFOAM

Standard Count	Actual Count	Percent of Standard	Standard Count	Actual Count	Percent of Standard
	Styrofoam			Tile Floor	
60905	79116		61685	54300	
60509	79451		61636	54383	
60889	79827		61136	54381	
61046	79384		61329	54531	
60792	79376		61047	54569	
304141	397154	130.6%	306833	272164	88.7%

TABLE 6

COMPOSITE GRADATIONS FOR WEARING AND BINDER COURSE MIX

U. S. Sieve	Composite Gradation Per Cent Passing Wearing Course	Composite Gradation Per Cent Passing Binder Course
1"		100.0
3/4"	100.0	98.8
1/2"	97.4	81.8
3/8"	82.0	-
No. 4	58.0	45.2
No. 10	47.4	38.7
No. 40	26.3	23.1
No. 80	10.8	9.2
No. 200	6.8	4.7

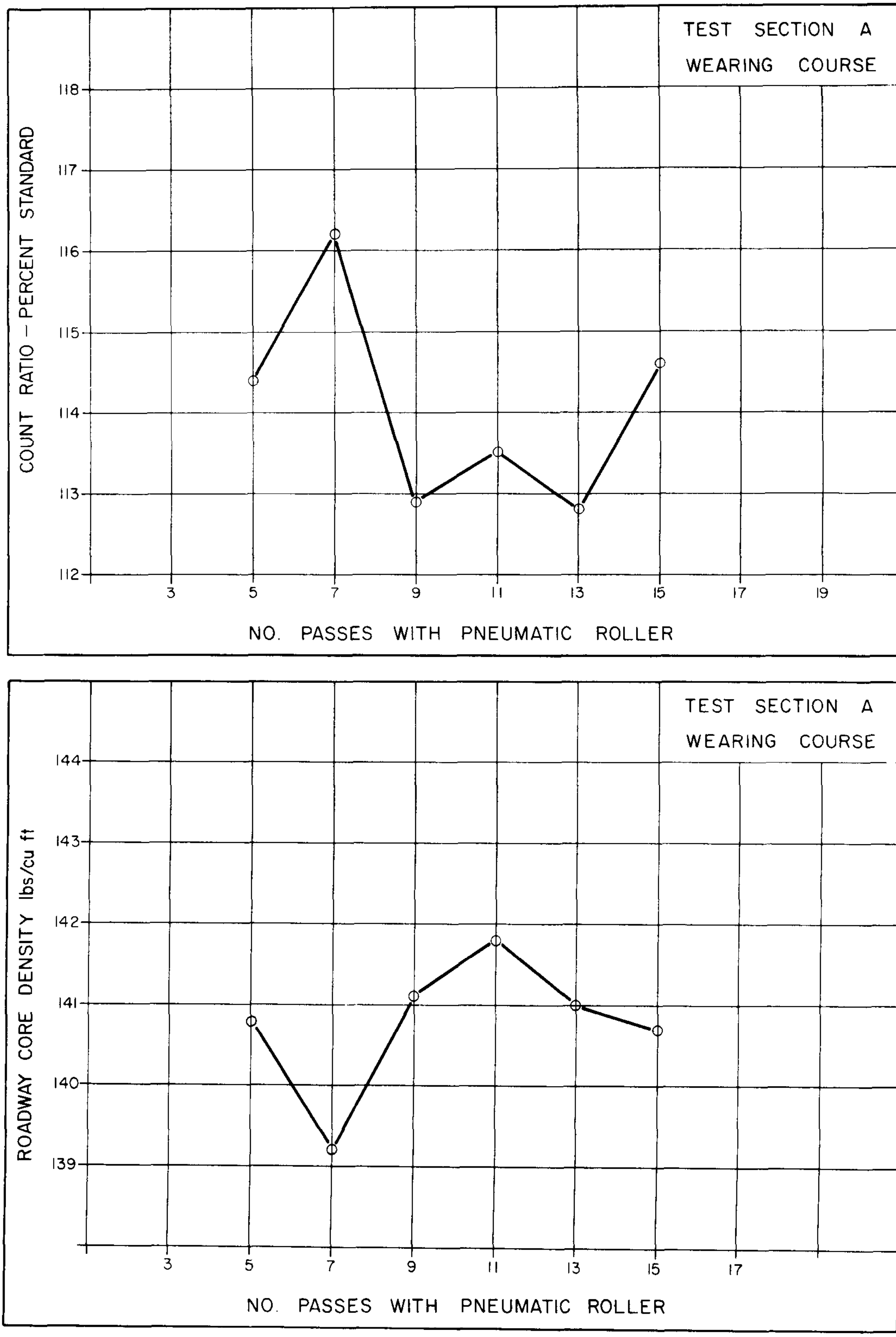
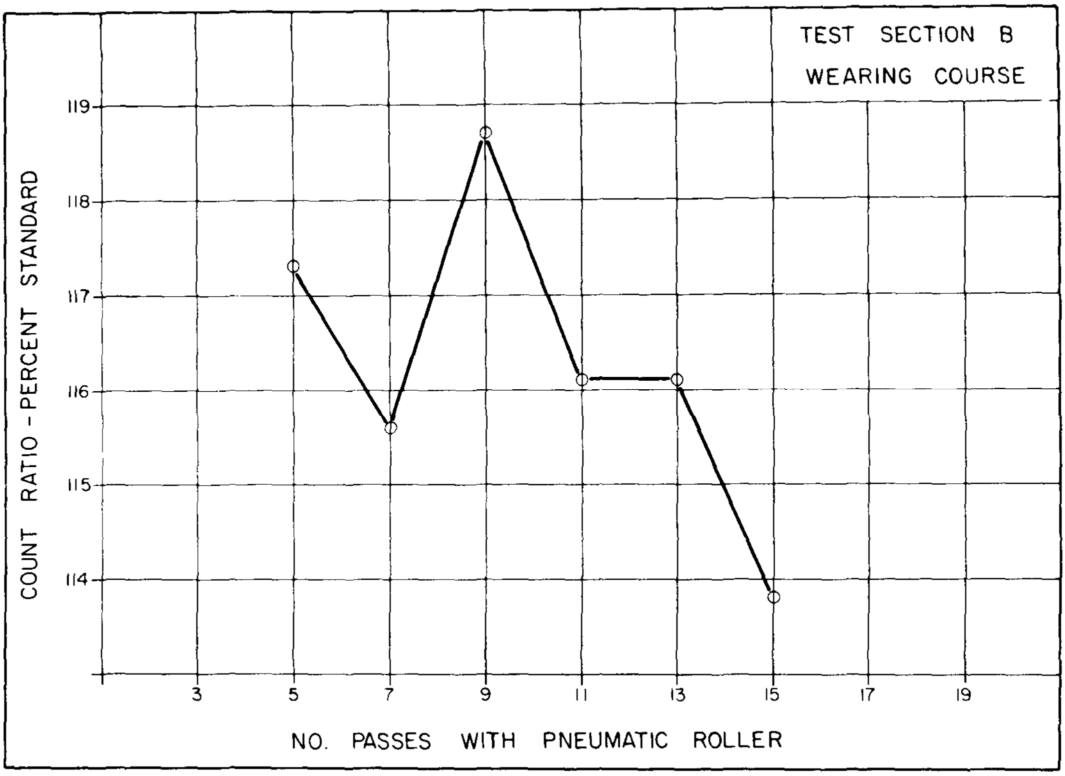


Figure 9 - Relationship of the Percent of Standard Readings and the Roadway Core Densities with the Number of Passes of the Pneumatic Roller for Test Section A on the Wearing Course Mix.



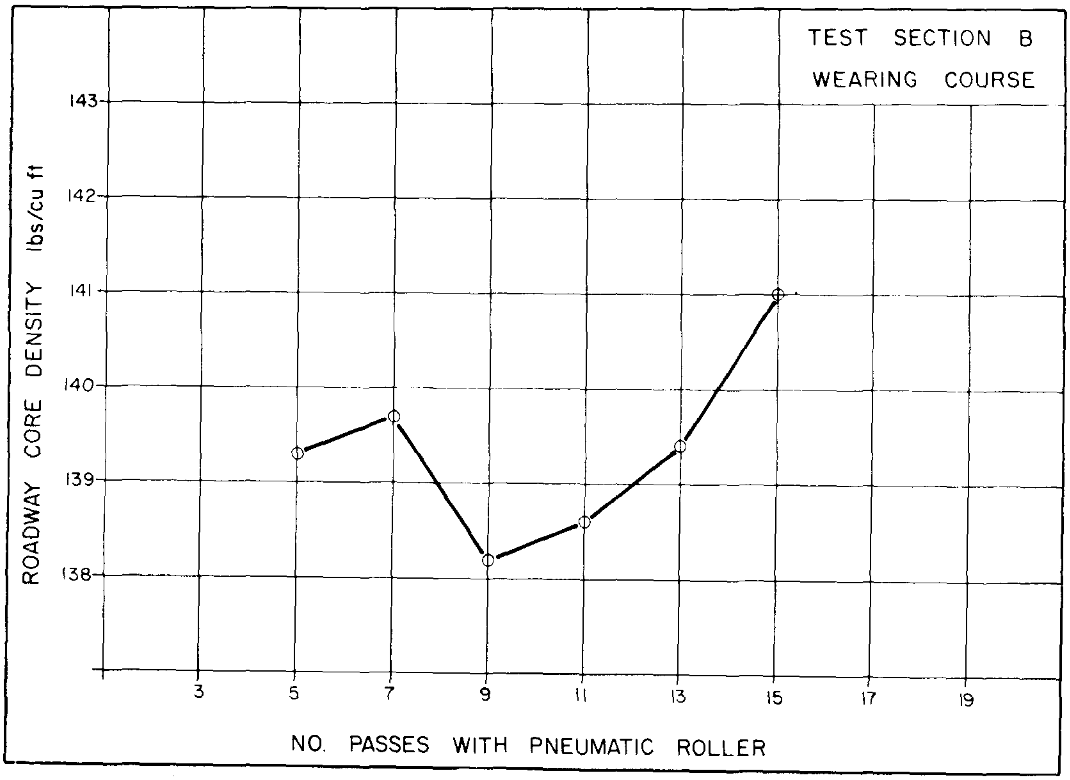
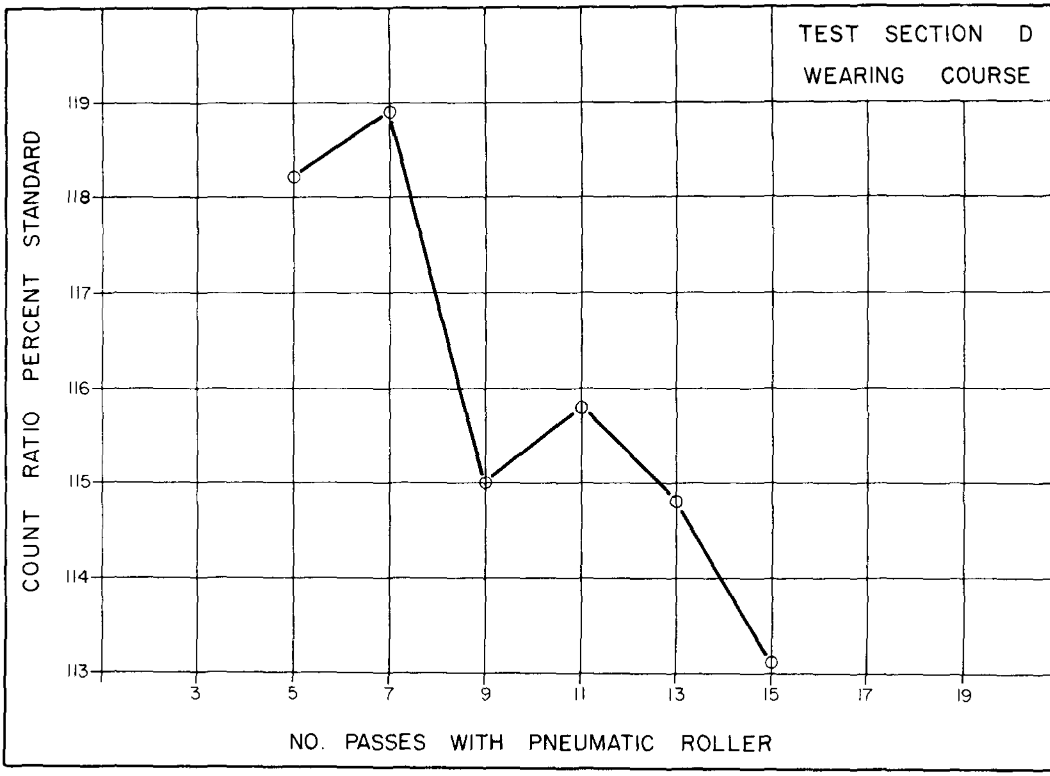


Figure 10 - Relationship of the Percent of Standard Readings and the Roadway Core Densities with the Number of Passes of the Pneumatic Roller for Test Section B on the Wearing Course Mix.



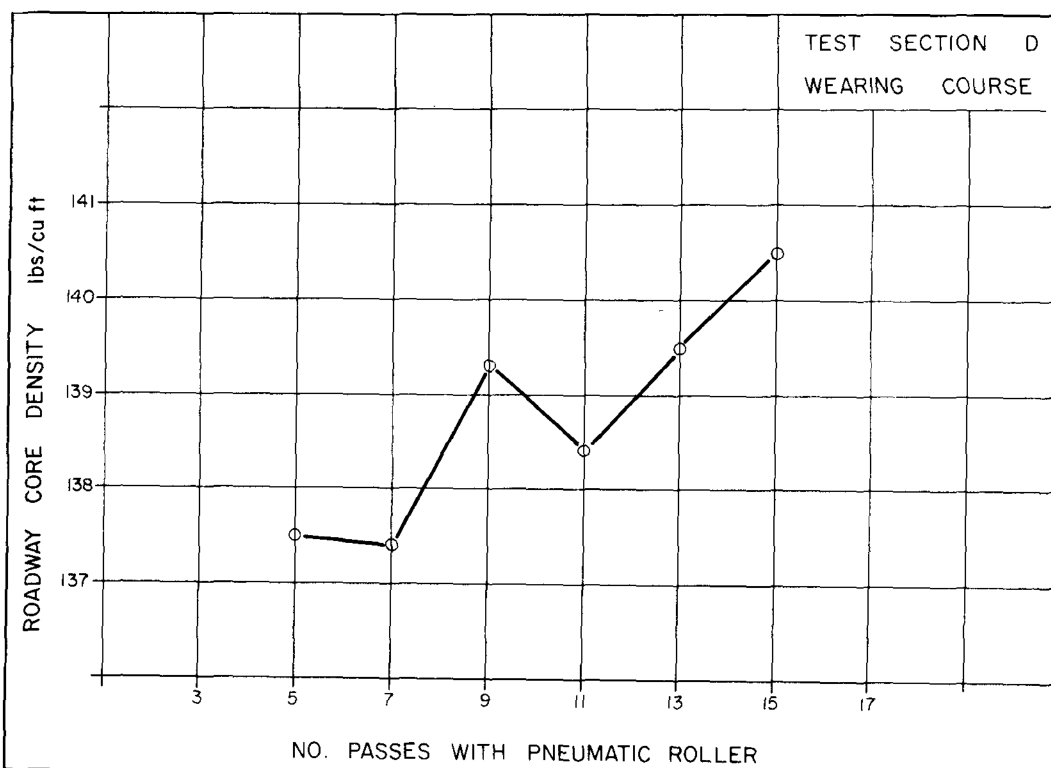
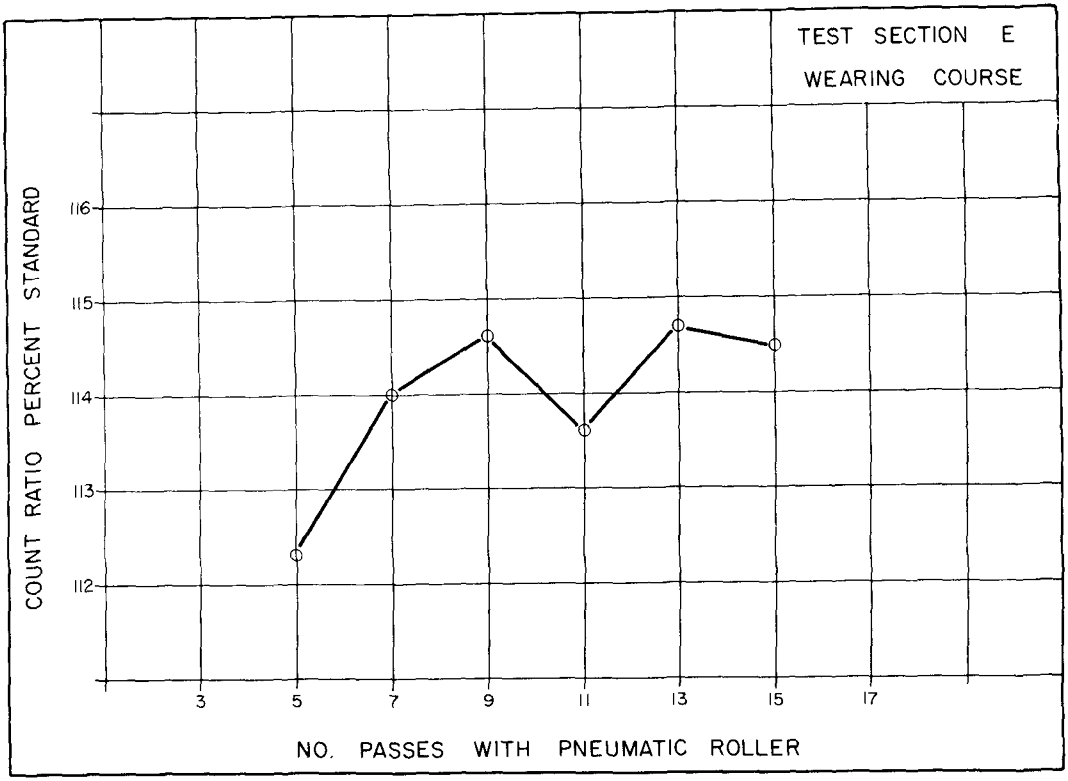


Figure 12 - Relationship of the Percent of Standard Readings and the Roadway Core Densities with the Number of Passes of the Pneumatic Roller for Test Section D on the Wearing Course Mix



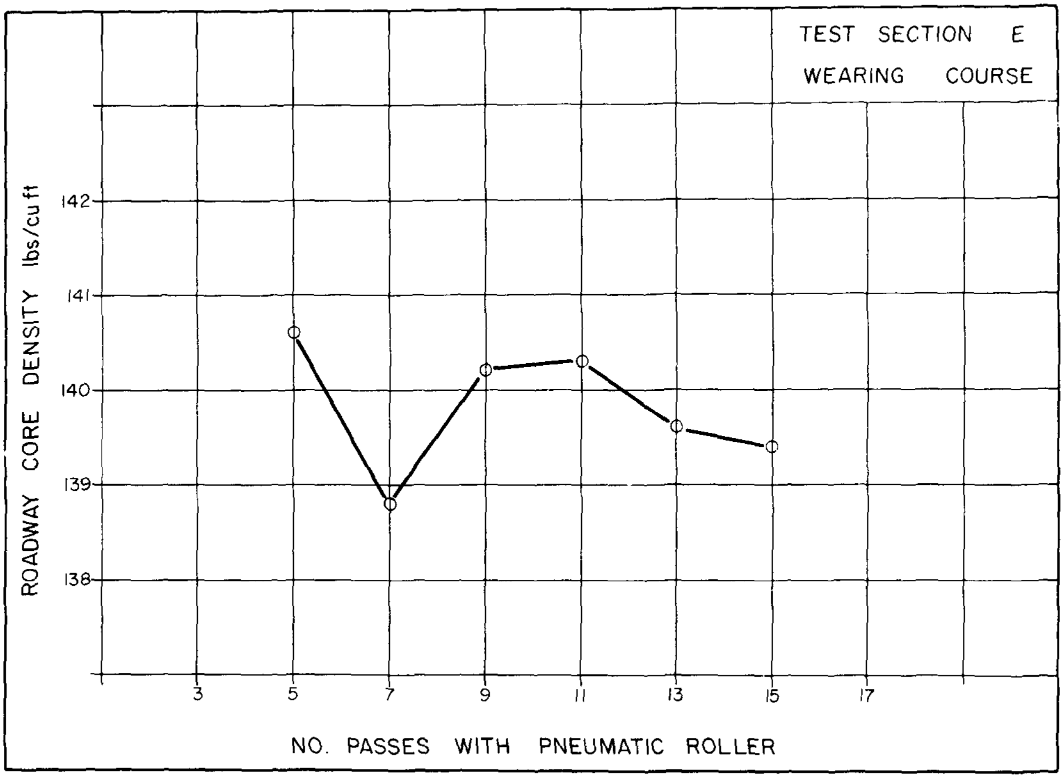
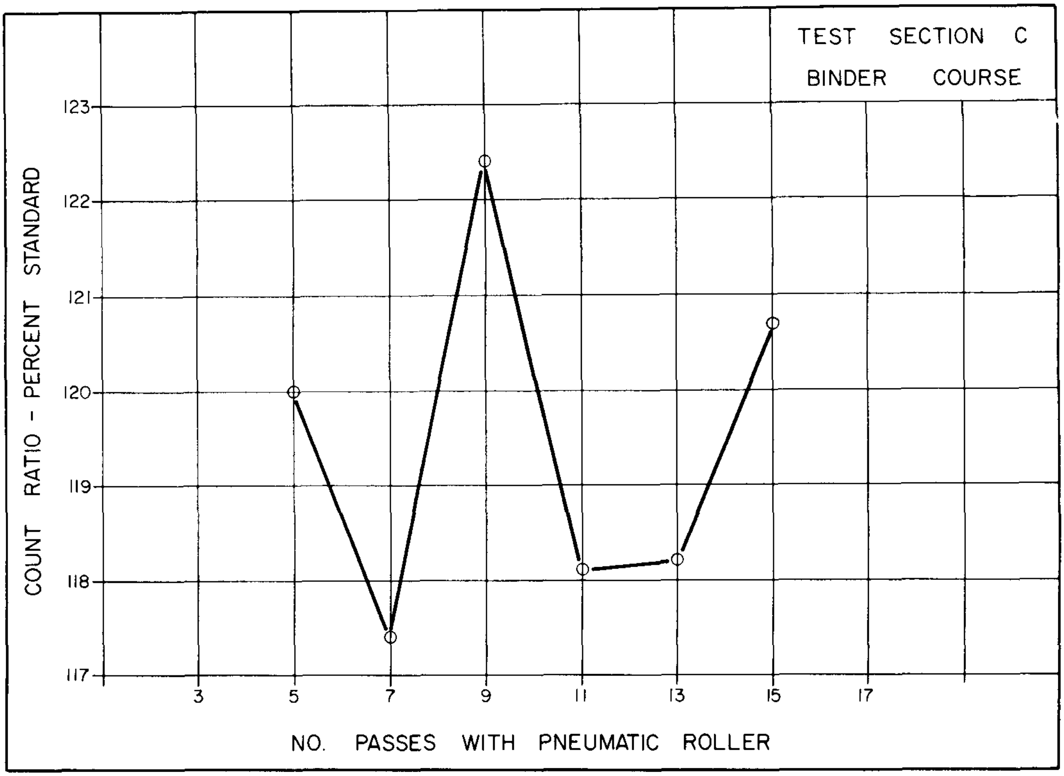


Figure 13 - Relationship of the Percent of Standard Readings and the Roadway Core Densities with the Number of Passes of the Pneumatic Roller for Test Section E on the Wearing Course Mix.



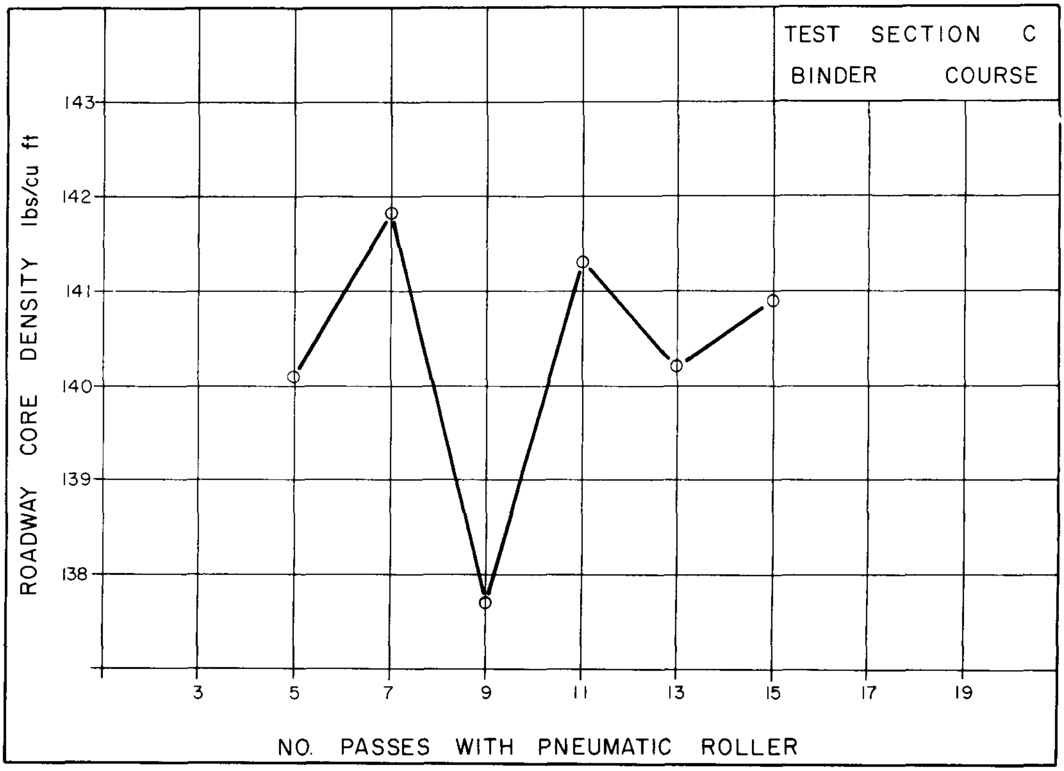


Figure 16 - Relationship of the Percent of Standard Readings and the Roadway Core Densities with the Number of Passes of the Pneumatic Roller for Test Section C on the Binders Course Mix