B.E. King

COMMISSIONER OF HIGHWAYS

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT, KENTUCKY 40601

December 3, 1970

H-2-15
ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
DIVISION OF RESEARCH
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MEMORANDUM TO: J. R. Harbison
State Highway Engineer
Chairman, Research Committee

SUBJECT: Research Report, "Relationship Between Soil Support Value and Kentucky CBR"; KYHPR-64-15; HPR-1(6), Part II.

The AASHO Operating Committee on Design was charged with the responsibility of developing pavement design procedures utilizing results from the AASHO Road Test. The first disclosure by the Committee was made at a conference in St. Louis, in May of 1962. The **Proceedings** (Special Report 73, HRB, 1962) contained a report by Messrs. Talbot, Huff and Liddle which was entitled *Use of Road Test Findings by AASHO Design Committee*. That report is the only published version of the **AASHO Interim Guide for the Design of Flexible Pavement Structures**. The use of the **Guide** has grown steadily amongst the states – especially those not having design criteria of their own. The **Guide** has been sanctioned by the Bureau of Public Roads. Incidentally, NCHRP Project 1-11/1, now nearing completion, was initiated to update and refine the **Guides**.

The Soil Support Value is an innovation of the AASHO Design Committee; it is a scalar parameter – that is, it is dimensionless and cannot be quantified by physical measurements. The AASHO Road Test soil (subgrade) was assigned a Soil Support Value of 3.0, crushed stone base was assigned a value of 10. By inference, crushed stone has a CBR of 100. At the outset of construction, samples of the subgrade soil were made available to the several highway agencies. CBR tests performed here yielded 5.5 *(Note: CBR values reported by the Division of Materials; cf. Shook and Fang, HRB Special Report 66 (1961), was 7.6 – which included a correction factor based on "clay plus P.I.", without which the CBR reduced to 6.3)*. Using 5.5 as the preferred CBR, and equating this to a Soil Support Value of 3.0, the resulting, two-point correlation permitted early comparisons between the Kentucky design criterion (1958) and the AASHO **Guide**. The preliminary correlations between the criteria were remarkably good, but further validation necessarily awaited more exhaustive verification of the CBR-vs-Soil Support Value relationship. This study was proposed and authorized under the HPS-HPR program in 1964, but the principal portion of the work was done during the past two years. It seemed necessary to obtain new samples of the Road Test Soil; fortunately, a remnant of the original stockpile had been preserved by the Illinois Highway Department.

Another complication arose from the fact that the subgrade soil at the Road Test was not compacted to the density and moisture content at which the Kentucky CBR measurement was made.

All of those technical difficulties have now been resolved on the basis of empirical correlations

– which are merely practical applications of soil mechanics.

The study was not intended to be an evaluation of test methods, but rather a correlation amongst test methods, test conditions and an array of soils. The results enable (or provide) a point of entry into the AASHO nomographs when the Kentucky CBR is known.

Respectfully submitted,

Jas. H. Havens,
Director of Research

Attachment

cc: Research Committee

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Director, Division of Materials
Director, Division of Photogrammetry
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Research Report

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RELATIONSHIP BETWEEN SOIL SUPPORT VALUE AND KENTUCKY CBR

KYHPR-64-15; HPR-1(6), Part II

by
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Division of Research
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In cooperation with the
U. S. Department of Transportation
Federal Highway Administration

December 1970

ABSTRACT

RELATIONSHIP BETWEEN SOIL SUPPORT VALUE AND KENTUCKY CBR

Three slightly different correlations between Kentucky CBR's and the AASHO Road Test soil support values were developed. The first relationship was made by assuming a logarithmic scale between Kentucky CBR's of 5.2 and 100, which corresponded to values on the soil support scale of 3 and 10, respectively. The Kentucky CBR of 5.2 was determined by performing tests on the AASHO road subgrade soils. For practical purposes, the AASHO Road Test crushed stone base material was assumed to be a "100 percent CBR material" (this assumption was based on CBR data previously reported by Shook and Fang). The second correlation was obtained by assuming a logarithmic scale between Kentucky CBR's of 5.2 and 90, corresponding to values on the soil support scale of 3 and 10, respectively. The third relationship was constructed through computations using actual traffic data, the Kentucky flexible pavement design curves and the AASHO Design Chart ($P_T = 2.5$). Computed soil support values of 3 and 10 corresponded to Kentucky CBR's of 6 and 90, respectively. Computed values of soil support were plotted to an arithmetic scale and Kentucky CBR's were plotted to a logarithmic scale. In a range of Kentucky CBR's varying from about 4 to 40, the relationship was linear, while from 40 to 90, the curve was concave upward. There was reasonable agreement between a Kentucky CBR of 5.2, determined by tests, and 6, determined through computations.

Comments are made regarding the Kentucky CBR testing procedure. In particular, it is noted that Nomographs C and D in Appendix A of the AASHO Guide which relate Kentucky CBR's and soil support values are not valid because the Kentucky CBR testing procedure does not permit the substitution of dynamic compaction in lieu of static compaction for molding CBR soil specimens.

Several ASTM and Kentucky CBR tests were performed at different molding moisture contents and compactive energies on the AASHO embankment soil, four representative Kentucky soils, and one soil from the state of Ohio. These data were compared to CBR data previously reported by Shook and Fang. For CBR's ranging from about 4 to 12, a relationship was developed between Kentucky and ASTM CBR's. Within this range of values, Kentucky and ASTM CBR's are approximately equal. Molding specimens under the static pressure of 2000 pounds per square inch as used in the Kentucky CBR procedure produced specimens with initial dry densities that averaged about six percent higher than those obtained by AASHO Designation: T99-57. CBR's and axial swell values were also higher. For soil specimens molded at the same initial dry densities, CBR's of statically compacted specimens are distinctively lower than those observed for dynamically compacted specimens. For relatively small decreases in initial dry densities, there were very large decreases in CBR's. This probably accounts for discrepancies that have been observed between field and laboratory CBR's.

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INTRODUCTION

Subgrade strengths of the upper three feet of the embankment soils at the AASHO Road Test were expressed in terms of a dimensionless, hypothetical soil support parameter *(1)* (Figure 1). The AASHO Road Test sections were constructed on one type of soil, A-6 (9 to 13); thus, only one point was obtained in plotting the road test performance equation. This point was assigned a soil support value of 3. A second point was established on the soil support scale from observations and analysis of the performance of various sections on Loop 4 having thick, crushed stone base materials. These studies indicated that about 4.5 inches of asphaltic plantmix surfacing on a soil with support characteristics of the crushed stone base should carry approximately 1000 applications of an 18-kip, single axleload per day for a 20-year period to a terminal serviceability index of 2.0. By projecting a line from 1.98 (4.5 x 0.44), the thickness index, D, for 4.5 inches of asphaltic surfacing through 1000 on the center structural number (unweighted) scale, a second point on the soil support scale was established and arbitrarily assigned a value of 10. A linear scale was assumed between the soil support values of 3 and 10 and extended to 1. The soil support scheme did not specify a method of test for determining soil support capacity of a given soil. However, some means must be made available to correlate the hypothetical soil support values (S) and strength values resulting from a selected test method.

Preliminary comparison between Kentucky designs and AASHO Road Test results for several conditions indicated that a Kentucky CBR of 5, or slightly greater, corresponded to a soil support of approximately 3. Verification of this relationship and the correlation of Kentucky CBR's and soil support values were the main concerns of this study. Such correlation would serve to provide a basis for comparing flexible pavement designs from the AASHO Road Test with those based on Kentucky design criteria. Another intent was to compare CBR data reported by Shook and Fang *(2)* with Kentucky CBR data and CBR data obtained using other test methods so as to provide a means for making closer comparisons among various design criteria employing the CBR parameter.

Correlation Curves C and D, Appendix A of the AASHO Guide *(1)*, relating to Kentucky CBR values and Soil Support values are misleading because of the conditions outlined in the guide for molding the CBR specimens are not the same as specified in the Kentucky CBR testing procedure. Although the Kentucky CBR specimen is molded at optimum moisture content determined from AASHO Test Designation T 99-57, Method A (See Table 1), the specimen is molded using static compaction rather than dynamic compaction, and the CBR specimen is soaked until swell virtually ceases. Either of the compactive efforts mentioned in the AASHO Guide may yield specimens with the same densities and moisture contents as obtained using a static compactive effort; however, Seed and Chan *(3)* presents data which indicates that the method -- static, dynamic, or kneading -- of compaction yields soil specimens with differing soil structures. When comparing samples prepared by static compaction and kneading compaction, there was a marked difference in the stress-strain relationships for samples compacted "wet of optimum". Data showing the effect, if any, of different types of soil structures on CBR strengths were not available.

The close similarity between the Kentucky and AASHO flexible pavement design criteria and the desire to provide a basis for comparing the two design procedures prompted this study. The general approach adopted by AASHO for designing flexible pavements is basically the same as used in Kentucky since 1948 *(4)*. Both design methods are formulated to relate empirically 1) soil support capability, 2) traffic loading, and 3) pavement thickness.

Included herein are comments concerning 1) the Kentucky CBR test procedure, in order to clarify misunderstandings that may have arisen; 2) results obtained from CBR tests on soils used in the embankment at the AASHO Road Test, four typical Kentucky soils and one from Ohio; and 3)

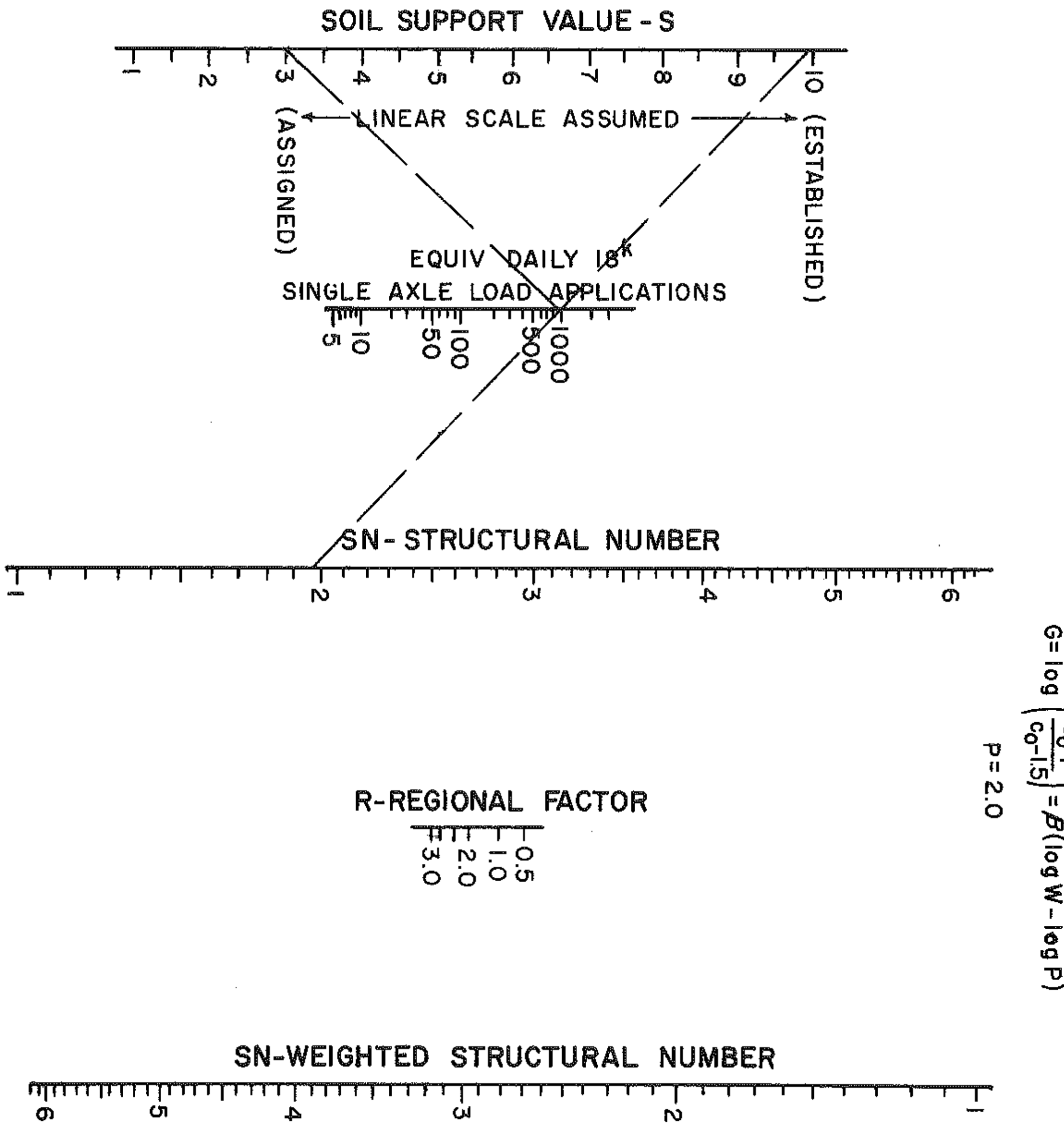


Figure 1. AASHO Flexible Pavement Design Chart (P_t = 2.0).

relationships between Kentucky CBR's and CBR's derived from specimens molded according to AASHO Test Designation: T99-57, Method B. CBR values resulting from this study are compared to CBR values reported by Shook and Fang *(2)*. Finally, three nomographs relating Kentucky CBR's with values on the Soil Support scale are presented.

KENTUCKY CBR TESTING PROCEDURE

Currently there is not an AASHO or ASTM standard CBR testing procedure involving static compaction, although static compaction is used in ASTM suggested methods of test *(Cf. 5)* as an alternate compaction method for preparing test specimens for permeability, consolidation, volume-change expansion pressure, and triaxial compression tests. Static compaction does influence the structure of soils, i.e., the physical properties of specimens prepared with static compaction differ from those of specimens compacted dynamically or by kneading-type methods *(5)*.

The CBR testing procedure (APPENDIX A) presently used in Kentucky, one used since 1948, was modeled by Baker and Drake *(4)* after a procedure suggested by Stanton *(6)*. Essentially, Stanton's method consisted of determining in the laboratory the CBR of the subgrade soil (and untreated base and subbase material) at optimum moisture content and maximum dry density. The maximum dry density and optimum moisture content are obtained from a moisture content-dry density curve derived by molding several soil specimens in a 6-inch diameter mold at various moisture contents under a static compaction pressure of 2000 pounds per square inch *(6)*. Stanton's suggested methods of tests for compacting soil specimens also provided an alternate compaction method, primarily for field use. Specimens are compacted dynamically in five equal layers in a 6-inch diameter mold. A 10-pound hammer is dropped from a height of 18 inches and each layer receives 20 blows. Apparently, this method of compaction was one of the methods mentioned in the AASHO Guide *(1)* -- Kentucky's CBR test procedure does not contain a provision for replacing static compaction with dynamic compaction. Obviously, the two compaction methods may not yield comparable CBR results, considering that a soil does not have a "maximum density and optimum moisture content", but rather these values vary with compactive effort and, to some unknown extent, with the method of compaction. Although the static pressure of 2000 pounds per square inch was considered standard in Stanton's procedures, it was noted that, for special tests to duplicate in situ density and moisture content, the static load could be reduced or increased as necessary. Other features of Stanton's procedure included compacting the CBR specimen from both ends, provisions for treating soils containing rocks, a specified rate of loading for compacting and penetrating the specimens, subjecting the specimen to a 4-day soaking period with a provision of reducing the soaking period for porous or cohesionless soils, and the use of a surcharge weight during penetration of granular materials.

Significant changes made by Baker and Drake *(4)* in Stanton's CBR testing procedure consisted of 1) soaking the specimen until axial swell virtually ceases, 2) molding the specimen at "Proctor conditions", however a 2000-pound per square inch pressure is used, 3) correcting the CBR load-deflection curve, 4) loading a 5-pound surcharge weight on the specimen at the start of penetration.

Inclusion of a soaking period of sufficient time in the CBR testing procedure to allow axial swell to virtually cease, i.e., "the specimen shall be soaked until the swell is less than 0.003 inch per 24 hours" (minimum soaking period of 72 hours), was prompted (in 1948) by departmental engineers who believed that the CBR specimens should be tested under what was considered "extremely critical conditions". Most agencies specify a four-day soaking period *(2)*. Whether a longer soaking period is necessary to reach an "extremely critical condition" is questionable. Chamblin *(7)* noted in a study of the effect of soaking period on CBR strengths that for a 4-day soaking period there was a large decrease in CBR; while for longer soaking periods, there was only a slight further decrease in CBR. Nevertheless, permitting swell to virtually cease does insure an "extremely critical condition", comparable probably to the worst situation in the field.

In the Kentucky CBR procedure, the specimens are intended to conform with conditions of AASHO Test Designation T99-57, Method A (compactive energy of 12,375 foot-pounds per cubic foot). However, observations *(8)* and data presented in this report suggest that the compactive effort of 2000 pounds per square inch is apparently greater than the compactive effort of T99-57, Method A. Consequently, the molded specimen has a higher density and a moisture content which is at or near optimum moisture content of AASHO T99-57, Method A. A specimen can be molded statically to a predetermined moisture content and dry density by molding the specimen to a predetermined height (volume), disregarding the 2000-pound per square inch pressure.

The maximum dry density in Stanton's method is obtained from a moisture-density curve derived from molding several specimens at various moisture contents and compacting the specimens under a 2000-pound per square inch pressure; or, alternatively, molding the specimens in five equal layers with a 10-pound hammer dropped 18 inches with each layer receiving 20 blows (compactive energy equal 33,000 foot-pounds per cubic foot). During soaking, Stanton's method specified a 10-pound surcharge weight while in the Kentucky procedure a 17.5-pound surcharge weight is used. In the Kentucky method, a 5-pound annular weight is used during penetration to center the piston; while in Stanton's method, such weight was used only for the case of granular materials.

Another feature added to the Kentucky method was the correction of the load-penetration curve. Experience has shown that CBR's for granular materials generally increase with depth of penetration while those for clays remain about the same or decrease slightly. This condition has been attributed to irregularities in the surface or in irregular distribution of moisture near the surface. But this condition also depends on the development of pore pressures under the load of the penetrating piston. For clays and silty materials having relatively low permeabilities, or cohesive soils, significant pore pressures build up during the early portion of loading, and part of the total load is carried by these pore pressures. As these pore pressures dissipate, the total load decreases and consequently the CBR's decrease with depth of penetration. If the clays have extremely low permeabilities, pore pressures may tend to remain about the same throughout penetration and the CBR's remain almost constant. For sands, or granular materials with high permeabilities, significant pore pressures do not develop. As a result, the density of the material under the piston increases with increasing depth of penetration and the load increases. Hence, in the early portion of the test, the CBR's are lower than in later stages of testing.

It is customary in most CBR testing procedures to select the CBR value at either 0.1- or 0.2-inch deflection. In the Kentucky method, the minimum CBR value is chosen from CBR's occurring at 0.1, 0.2, 0.3, 0.4, and 0.5 inches penetration. Baker and Drake *(4)* noted in developing pavement thickness curves that the minimum field and laboratory CBR's afforded the best comparative values between the two tests.

A paradox exists in the Kentucky CBR procedure in relation to pavement design. The Kentucky CBR testing procedure has been designed to reflect the worst field conditions, inasmuch as the CBR specimens are soaked until virtual cessation of swell and minimum value of CBR is selected from the load-penetration curve. However, the Kentucky CBR test is performed on specimens which have higher initial dry densities than those of standard compaction (AASHO T99-57) used in the field for controlling embankment compaction.

METHODOLOGY OF PREPARING CBR SPECIMENS

Characteristics of the different methods used in molding CBR specimens are shown in Table 1. Method 1 ("Standard Compaction") or AASHO Test Designation: T99-57, Method A, was used to

TABLE 1: ESSENTIALS OF COMPACTION METHODS USED TO PREPARE CBR SPECIMENS

Test Identification	Method 1	Method 2	Method 3[a]	Method 4	Method 5[b]	Method 6
Standard Identification	AASHO Designation: T99-57 ASTM Designation: D698-58T Method A	AASHO Designation: T99-57 ASTM Designation: D698-58T Method B	AASHO Designation: T99-57 ASTM Designation: D698-58T Method B	AASHO Designation: T99-57 ASTM Designation: D698-58T Method B	Kentucky CBR Testing Procedure	Kentucky CBR Testing Procedure
Mold					6	6
Diameter (in)	4	6	6	6	Variable	Predetermined
Height (in)	4.59	4.59	5.00	4.59	Variable	Predetermined
Volume (cu.ft.)	1/30	1/13.33	1/12.23	1/13.33		
Rammer						
Weight (lb)	5.5	5.5	5.5	10		
Free Drop (in)	12.0	12.0	12.0	18		
Face Diameter (in)	2.0	2.0	2.0	2.0		
Layer					1	1
Total Number	3	3	3	5	28.27	28.27
Surface Area (in^2)	12.57	28.27	28.27	28.27	Variable	Predetermined
Compacted Thickness (in)	1.7	1.7	1.7	1.0		
Compaction Effort					2000 lbs/in^2	Variable
Blows Per Layer	25	56	56	56	Static	Static
Energy (ft-lb/cu.ft.)	12,375	12,317	11,301	55,986	Compression	Compression
Material					3/4 inch	3/4 inch
Maximum size	No. 4	No. 4	No. 4	No. 4	YES	YES
Correction for oversize	NO	NO	NO	NO		

NOTES:

a. Method 3 is the same as Method 2 except sample height equals 5 inches instead of 4.59 inches.

b. See APPENDIX A for details of compaction method.

determine the moisture-density relationships of each of the soils tested. These relationships were used in preparing the Kentucky CBR specimens, Method 5. Basically, Method 1 consists of compacting three equal layers of soil in a 4-inch mold with each layer receiving 25 blows from a 5.5-pound hammer dropped 12 inches.

CBR specimens for testing under ASTM Test Designation: D1883-61T were prepared in three different ways. Method 2 ("Standard Compaction"), or AASHO Test Designation: T99-57, Method B, essentially involves compacting three equal layers of soil in a 6-inch mold with each layer receiving 56 blows from a 5.5-pound hammer dropped 12 inches. Method 3 is the same as Method 2, except the height of the sample was 5 inches instead of 4.59 inches. Method 4 ("Modified Compaction"), or AASHO Test Designation: T 180-57, Method B, consisted of compacting five equal layers of soil in a 6-inch mold with each layer receiving 56 blows from a 10-pound hammer dropped 18 inches.

CBR specimens for testing under the Kentucky CBR testing procedure were prepared in two different ways. Method 5 involved compressing the total sample under a static pressure of 2000 pounds per square inch. The volume of material used in this test method was determined from the moisture-density relationships of Method 1. Method 5 differed slightly from the Kentucky CBR testing routine. Normally, values of optimum moisture content and maximum dry density of Method 1 are used to calculate the amount of material for testing under the Kentucky procedure. In Method 5, the moisture content was varied over a wide range of values. Method 6 was basically the same as Method 5; however, the specimens were not molded under a static load of 2000 pounds per square inch, but were molded to a predetermined height (volume).

LABORATORY RESULTS

Soil samples were secured from stock-piled embankment material located at the AASHO Road Test site, four different locations in Kentucky, and one location in Ohio. The Kentucky samples were representative of a range of Kentucky soils. A portion of each sample was submitted to a routine laboratory testing program consisting of specific gravity, Atterberg limits, grain size analysis and standard compaction (Method 1). All tests were performed in accordance with AASHO standard test methods.

A summary of classification data for the six soils is given in Table 2, APPENDIX B. This table also includes mean values reported by Shook and Fang *(2)* for the AASHO Road Test sample. Soil samples from the AASHO test site, Fayette County, Clark County, and Ohio classified by the AASHO system as A-6 while samples from Fulton and Adair Counties classified as A-4 and A-7-5, respectively. Liquid limits of the soils from the six locations varied from 26 to 61; plasticity index varied from 1 to 34. Percentages of material finer than the No. 200 and No. 4 sieve for the six soils ranged from 71 to 91 and 92 to 100, respectively.

From 8 to 14 Kentucky CBR tests were performed on each of the soil samples from the six locations in accordance with Method 5 (APPENDIX A). However, moisture contents of the samples were varied in order to obtain a moisture content-dry density curve. A total of 67 Kentucky CBR tests were performed. These data are summarized in Table 3, APPENDIX C.

A total of 56 CBR tests were performed on each of the six soil samples in accordance with ASTM D 1883-61T. The number of tests performed on each of the six soils ranged from 8 to 29. The specimens were molded according to Method 2. These data are presented in Table 4, APPENDIX C. In Table 5, APPENDIX C, are the results of 20 CBR tests performed on the samples from each of the locations except Ohio. These specimens were compacted according to Method 3.

Five ASTM CBR tests were performed on the AASHO Road Test sample compacted in accordance with Method 4 (see Table 6 and Figure 11). Four Kentucky CBR tests were performed on the Fayette County soil using a static compactive effort other than 2000 pounds per square inch. The intent of these tests was to duplicate the moisture content-dry density curve obtained using Method 2 and to observe the resulting effects on CBR's. These data are shown in Table 6 and Figure 4. Also shown in Table 6 are the results of two ASTM CBR tests performed on specimens compacted by Method 4, with the exception that the compactive energies were 11,992 and 24,992 foot-pounds per cubic foot.

Dry density-, CBR-, and axial swell-molding moisture content curves for the samples from the six locations are presented in Figures 2 through 7. These data are also shown in Tables 3 through 5, APPENDIX C.

In Table 7, APPENDIX D, CBR's for each of the soils from the six locations are summarized at different optimum moisture contents and maximum dry densities which were determined by the compaction methods mentioned above. Two categories of Kentucky CBR's are shown. The first values shown in the left portion of the table are Kentucky CBR's at Method 1 optimum moisture contents. The other values are at the optimum moisture content and maximum dry density associated with Method 5. In the right-hand portion of the table, three categories of ASTM CBR's are shown. The first values represent CBR's for specimens compacted in accordance with Method 2 while the second group of CBR's are for specimens compacted in the same manner, except the specimen heights were 5 inches. Only one series of CBR tests was performed on specimens compacted by Method 4. The CBR's at optimum moisture content and maximum dry density for these tests are shown in the extreme right-hand portion of Table 7.

General relationships between ASTM CBR's and Kentucky CBR's determined at various molding conditions are presented in Figure 8. "Best fit" curves were drawn through the data points, from Table 7, using the method of least squares. Figure 8 displays a relationship between Kentucky CBR's at Method 1 optimum moisture contents and ASTM CBR's at Method 2 optimum moisture contents and maximum dry densities. A relationship between CBR's at Method 5 and Method 2 optimum moisture contents and maximum dry densities is shown in Figure 8. Figure 8 also shows a relationship between Kentucky CBR's at Method 1 optimum moisture content and CBR's at Method 3 optimum moisture content and maximum dry density.

AASHO ROAD TEST CBR DATA COMPARED

A total of 28 agencies *(2)* reported CBR data on the embankment soil at the AASHO Road Test. The majority of these agencies reported only one CBR value for a given set of conditions of compactive effort, moisture content and dry density. Seven agencies reported more than one CBR value, which usually was for varying conditions of compactive effort, moisture content and dry density. A variety of different methods were used by the various agencies in molding the CBR specimens. Inasmuch as CBR varies with compactive energy, moisture content, dry density, and probably the method of compaction, there were considerable differences in the reported CBR values, although several agencies molded their specimens approximately under the same conditions.

For conditions of similar testing, various plots of the reported CBR data *(2)* and data reported herein, dry densities and axial swell versus molding moisture contents, were made. These data are shown and compared in Figures 9 through 13.

Seven agencies *(2)* reported CBR values for specimens molded under static compaction in accordance with Stanton's suggested CBR test procedure, but the static pressure of 2000 pounds per square inch was not always used. These data and the dry density-, CBR- and swell-moisture content curves from

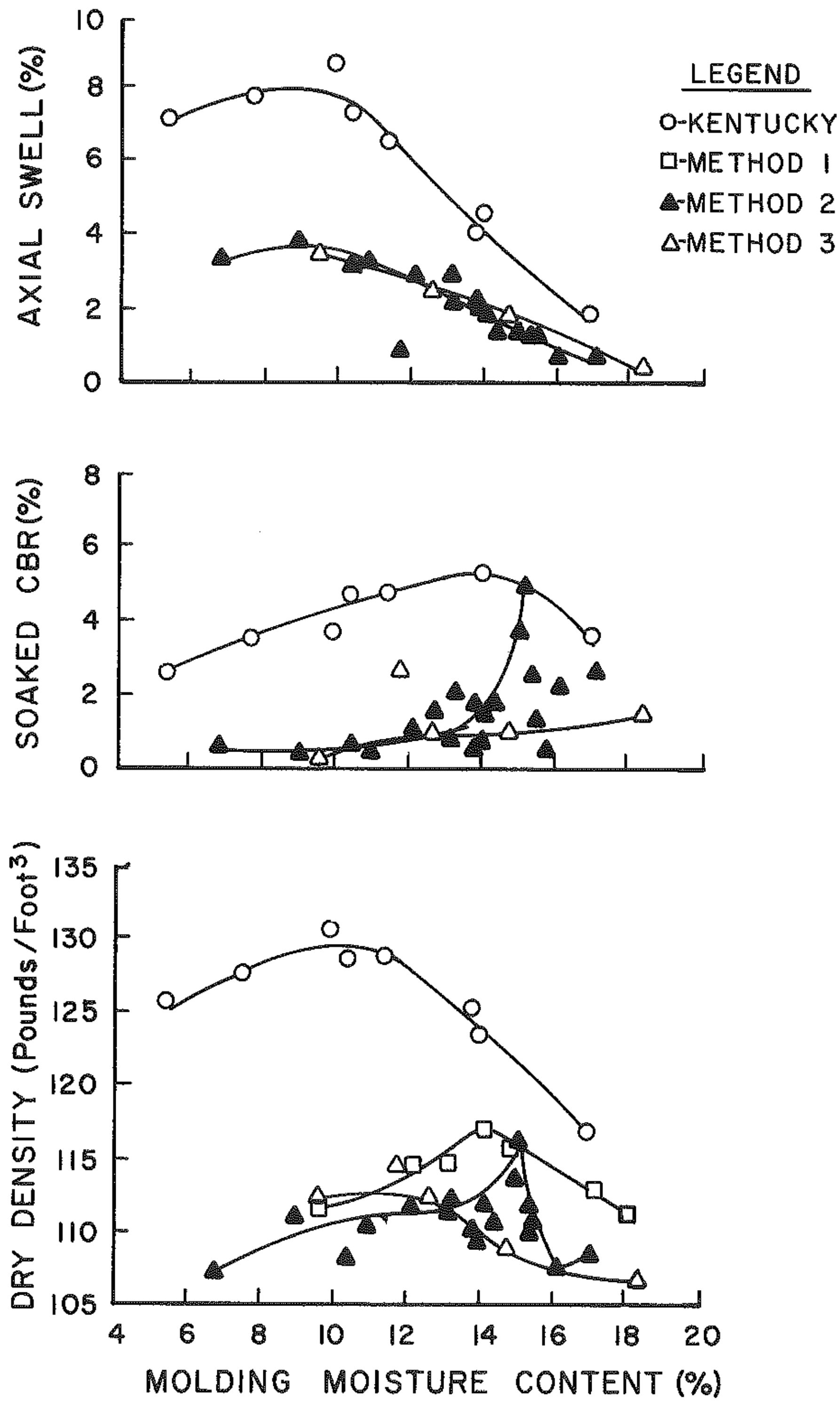


Figure 2. CBR Data, AASHO Road Test Soil Sample.

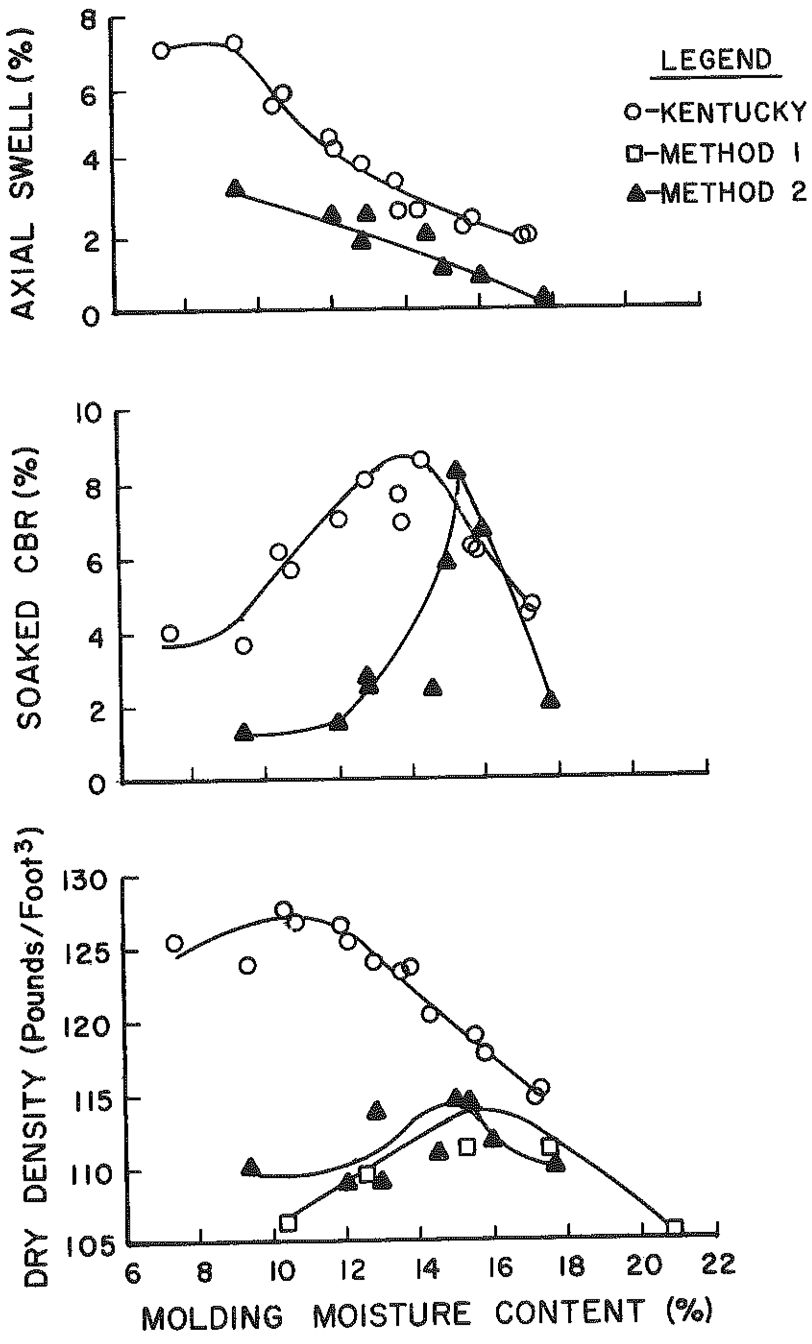


Figure 3. CBR Data, Soil Sample From State of Ohio.

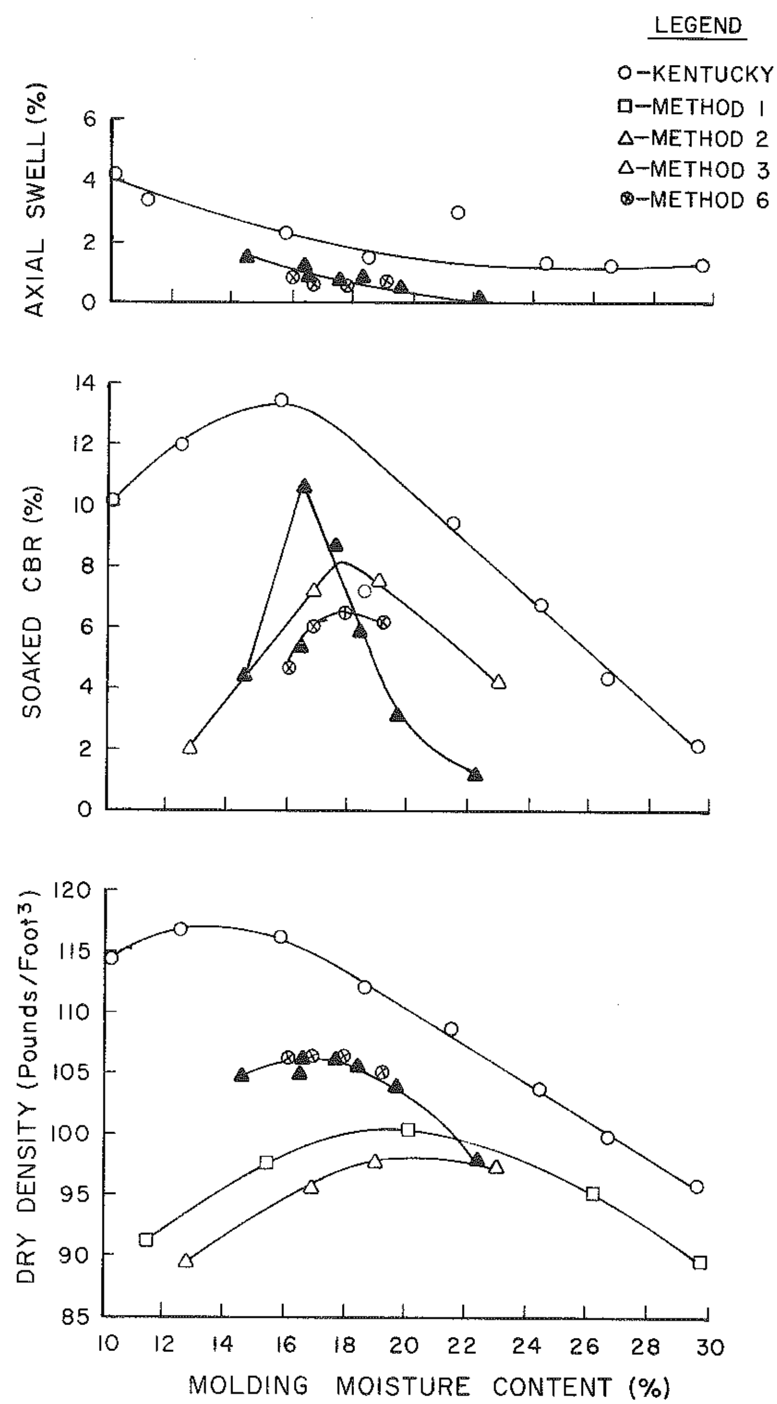


Figure 4. CBR Data, Fayette County Soil Sample.

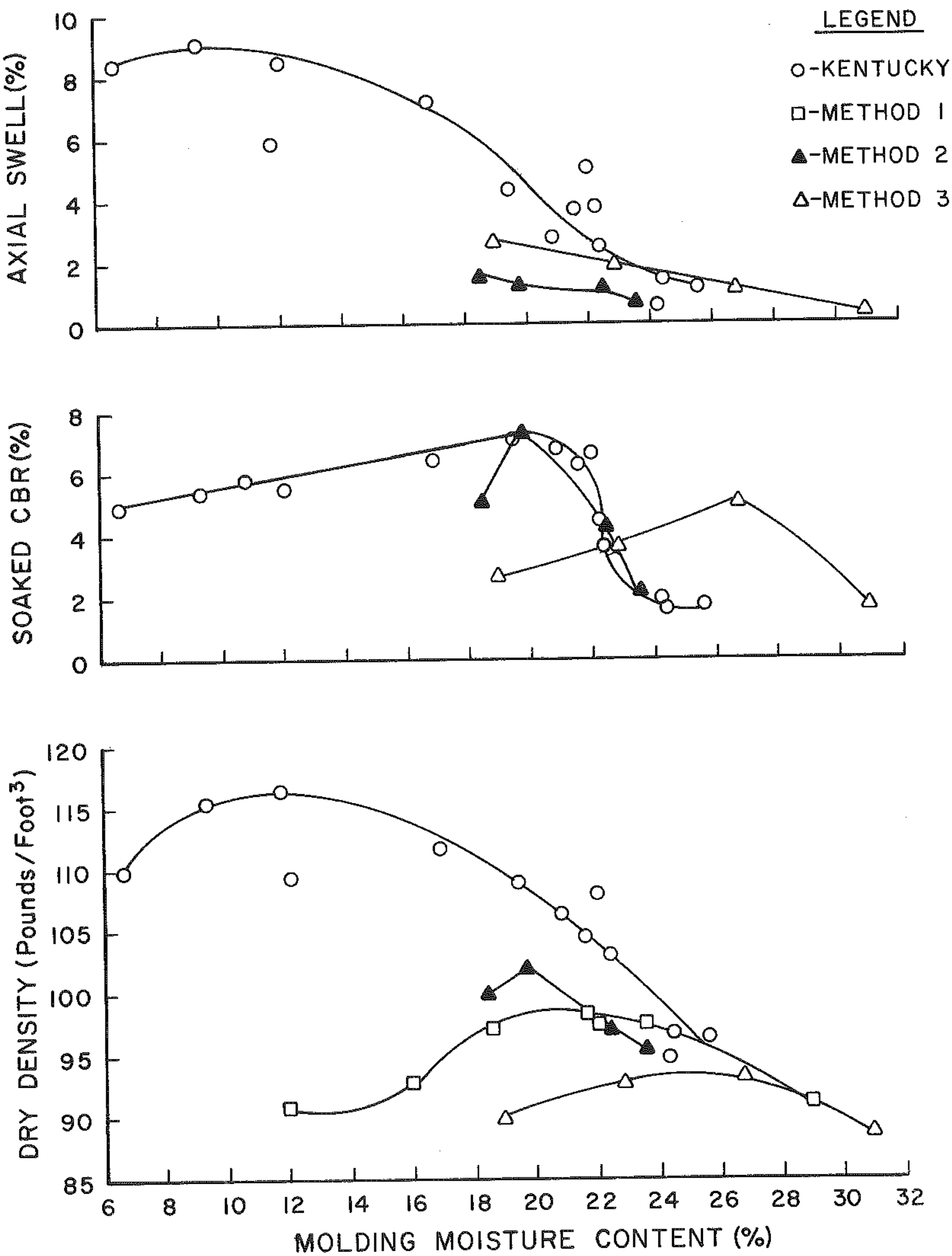


Figure 5. CBR Data, Clark County Soil Sample.

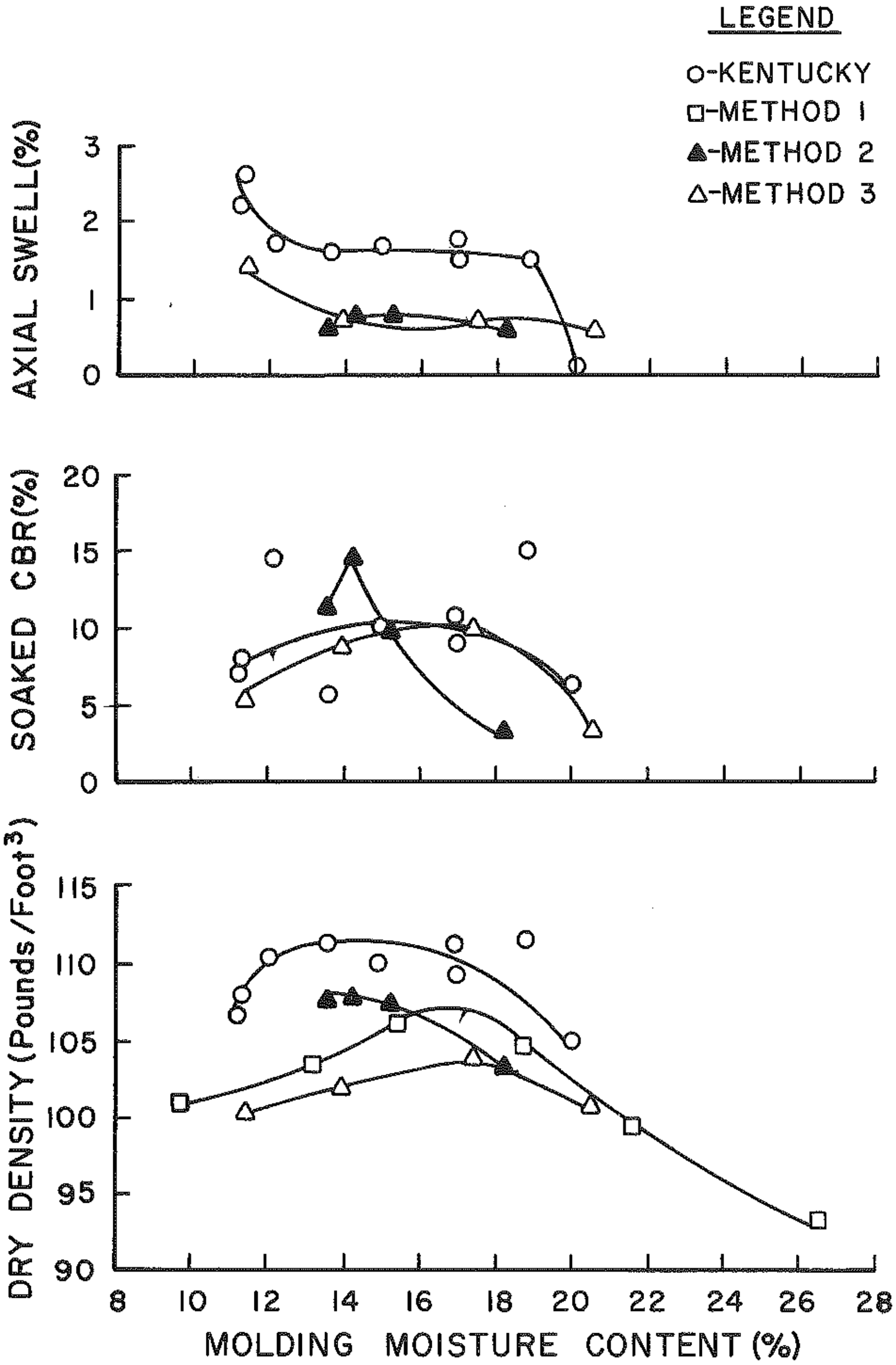


Figure 6. CBR Data, Fulton County Soil Sample.

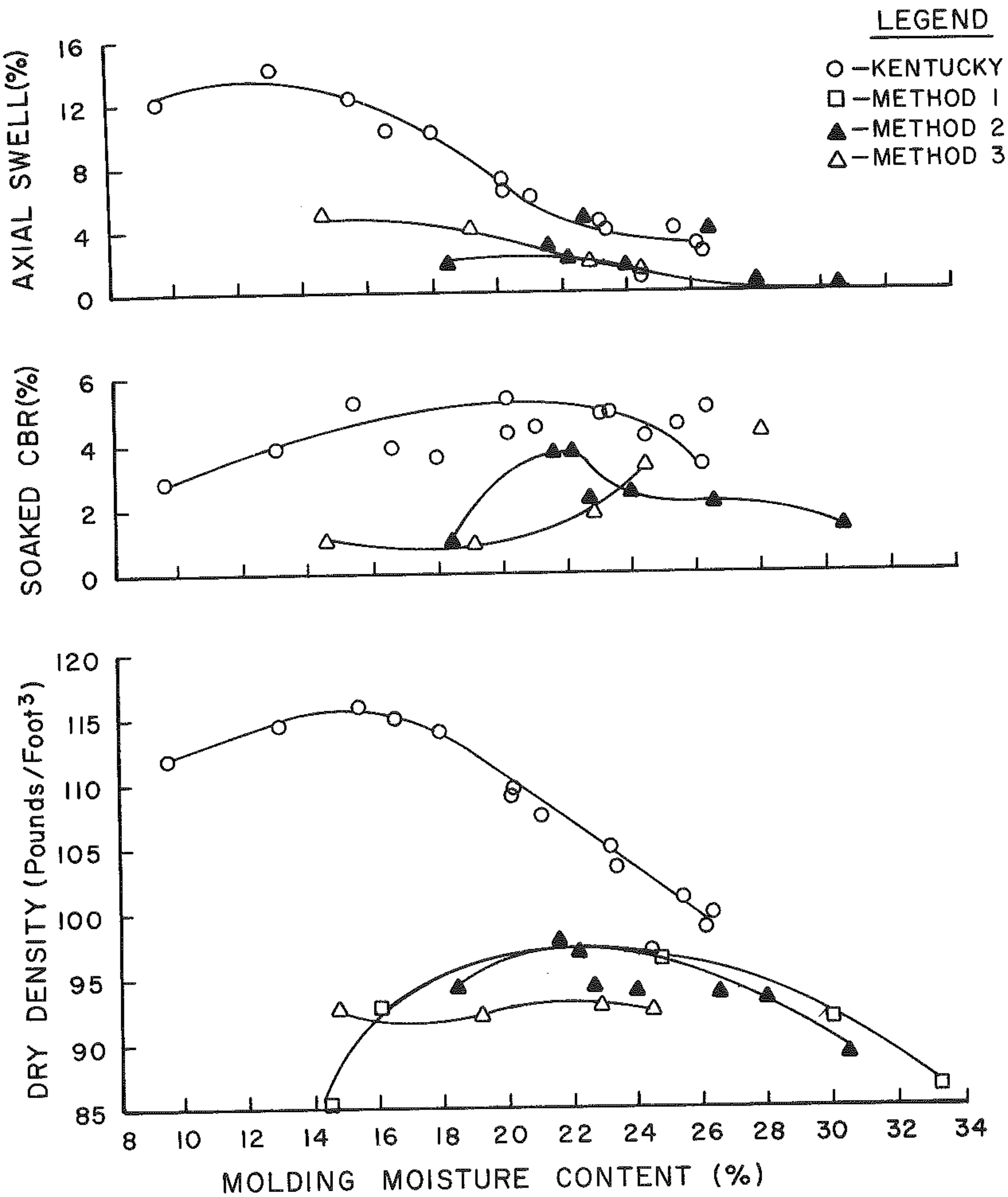
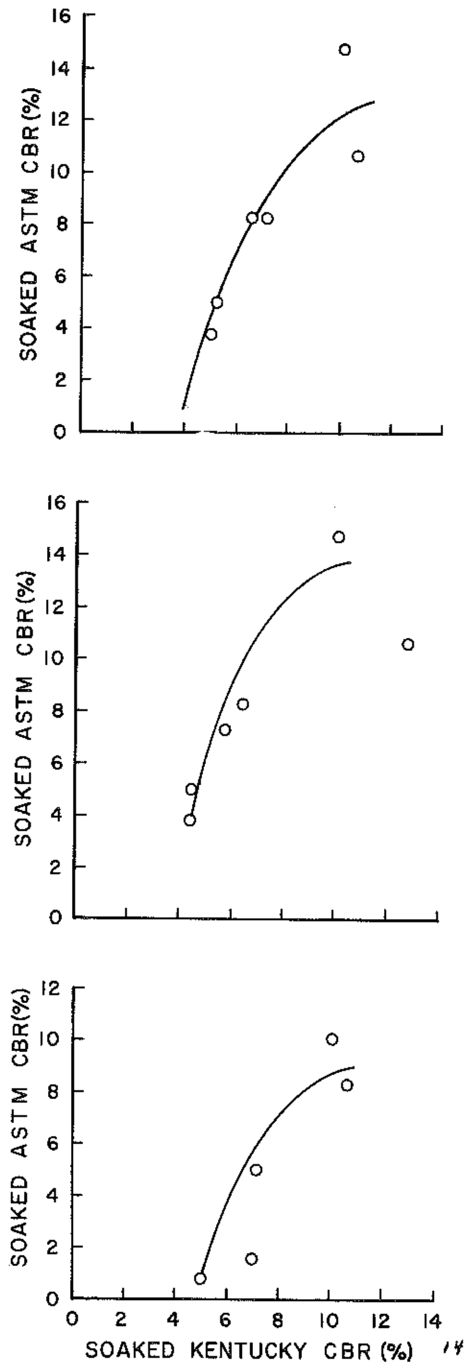


Figure 7. CBR Data, Adair County Soil Sample.



KENTUCKY CBRs, METHOD I
OPTIMUM MOISTURE CONTENT,
VERSUS ASTM CBRs, METHOD 2
OPTIMUM MOISTURE CONTENT

KENTUCKY CBRs, METHOD 5
OPTIMUM MOISTURE CONTENT,
VERSUS ASTM CBRs, METHOD 2
OPTIMUM MOISTURE CONTENT

KENTUCKY CBRs, METHOD I
OPTIMUM MOISTURE CONTENT,
VERSUS ASTM CBRs, METHOD 3
OPTIMUM MOISTURE CONTENT

Figure 8. Kentucky CBR - ASTM CBR Curves.

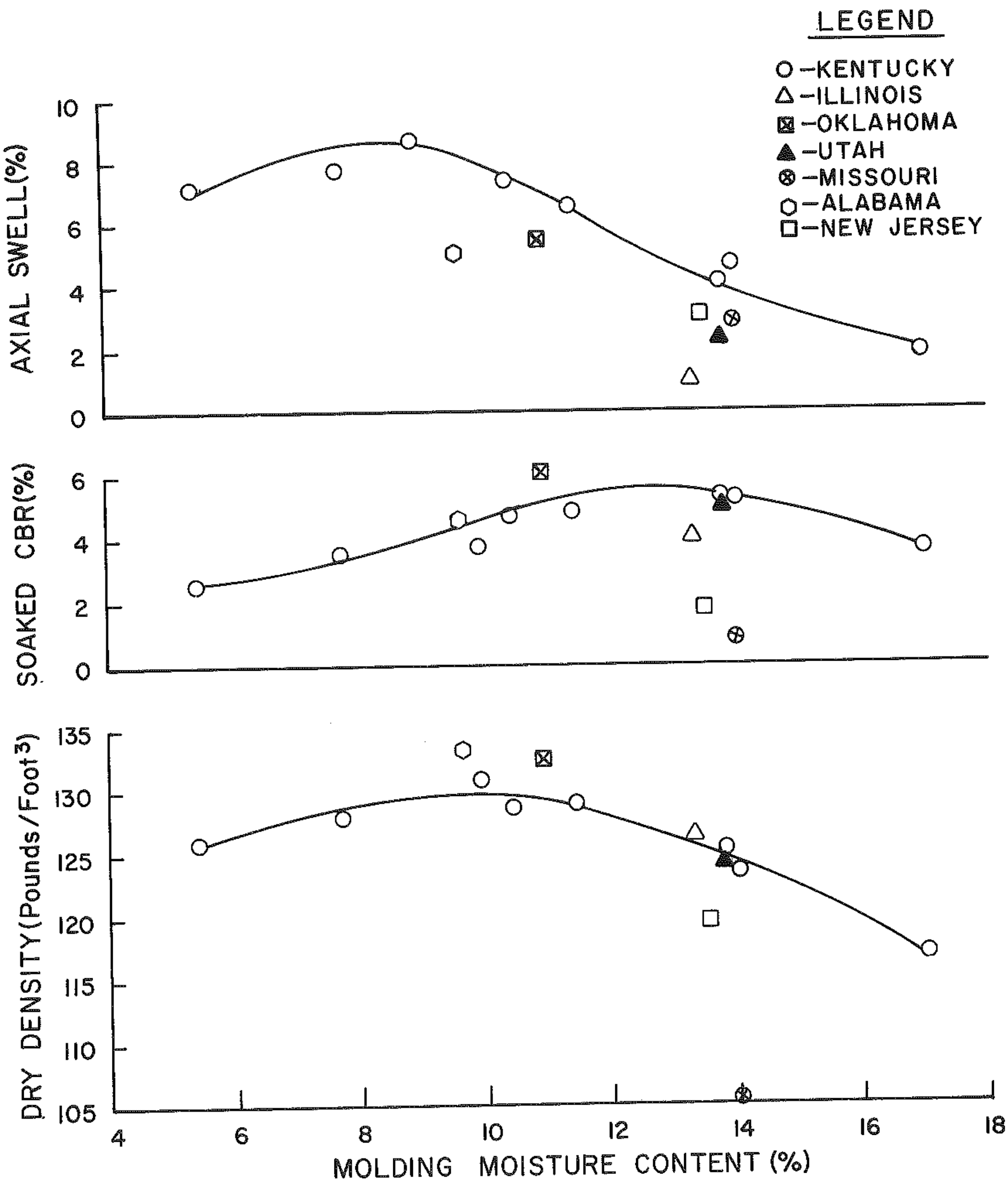


Figure 9. CBR Data, AASHO Soil Sample, Static Compaction.

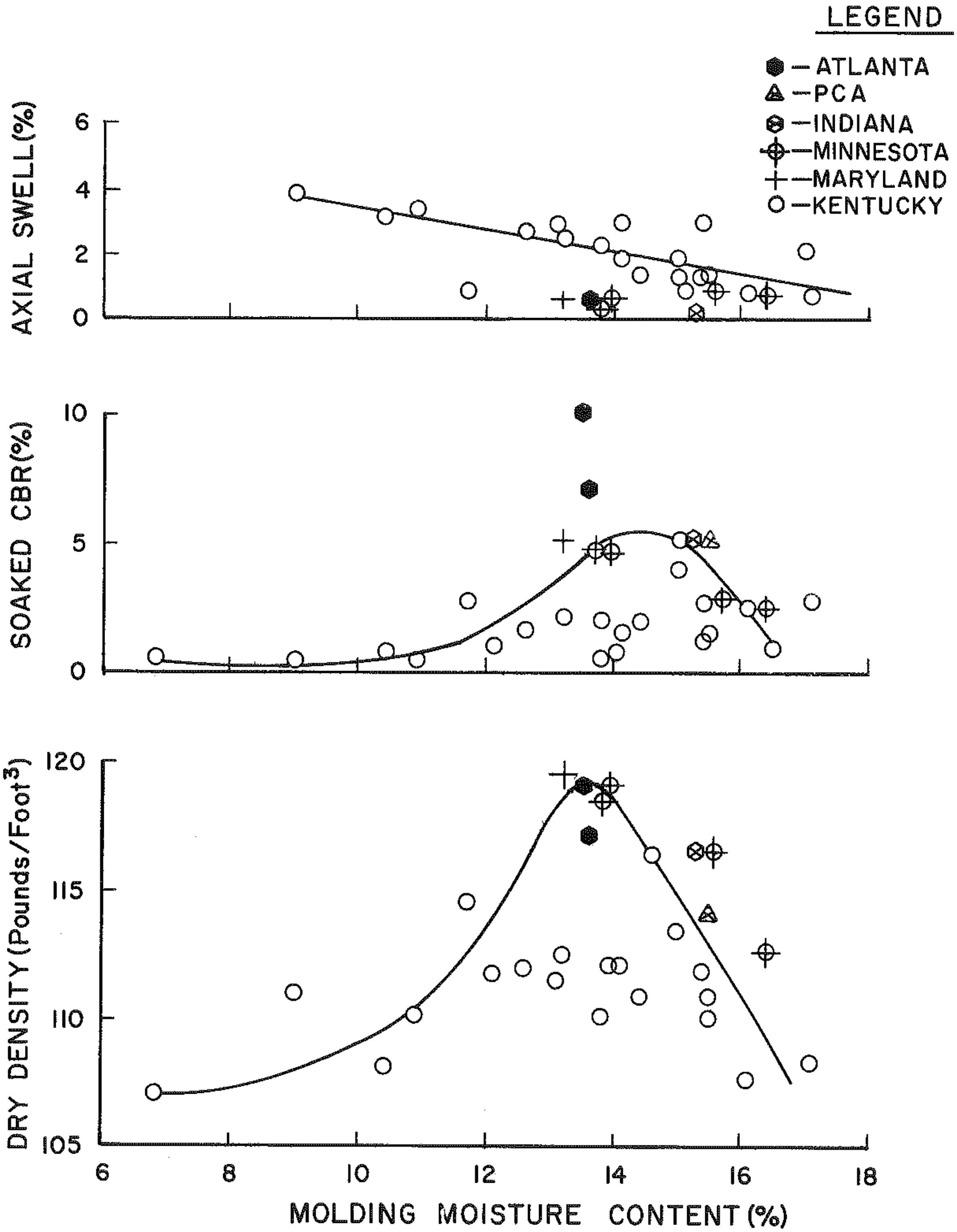


Figure 10. CBR Data, AASHO Soil Sample, Method 2.

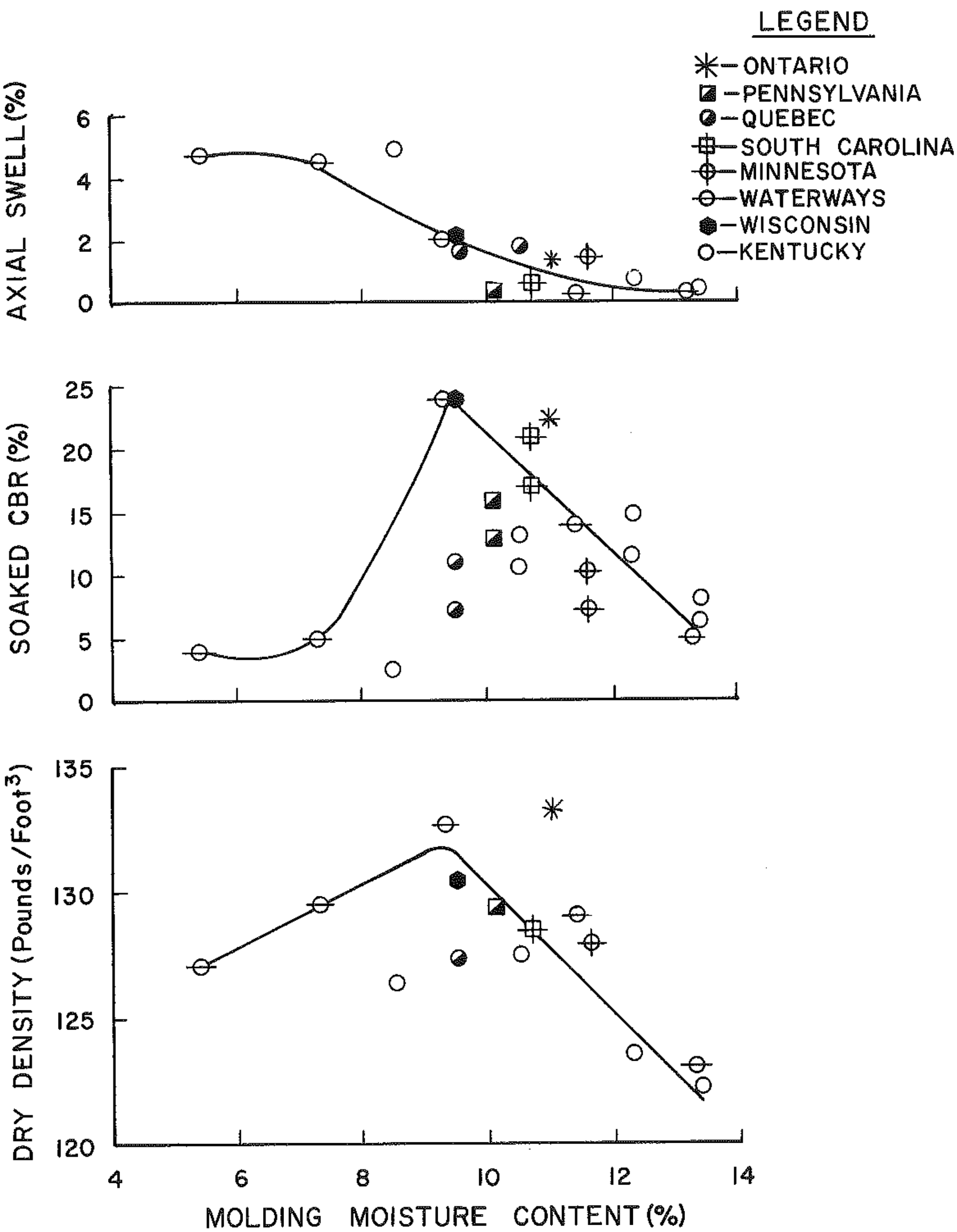


Figure 11. CBR Data, AASHO Soil Sample, Method 4.

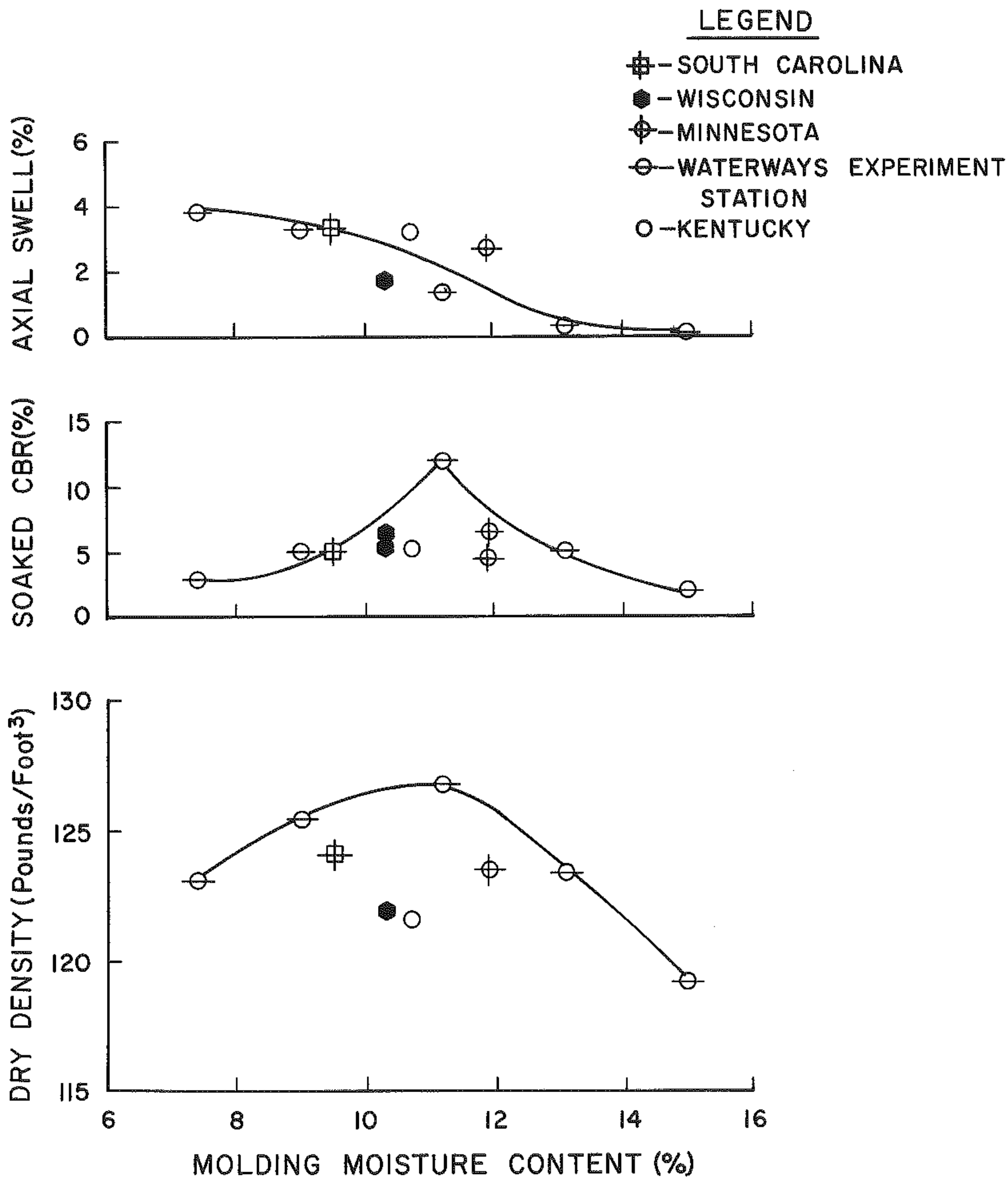


Figure 12. CBR Data, AASHO Soil Sample, Method 4 (25 blows/layer)

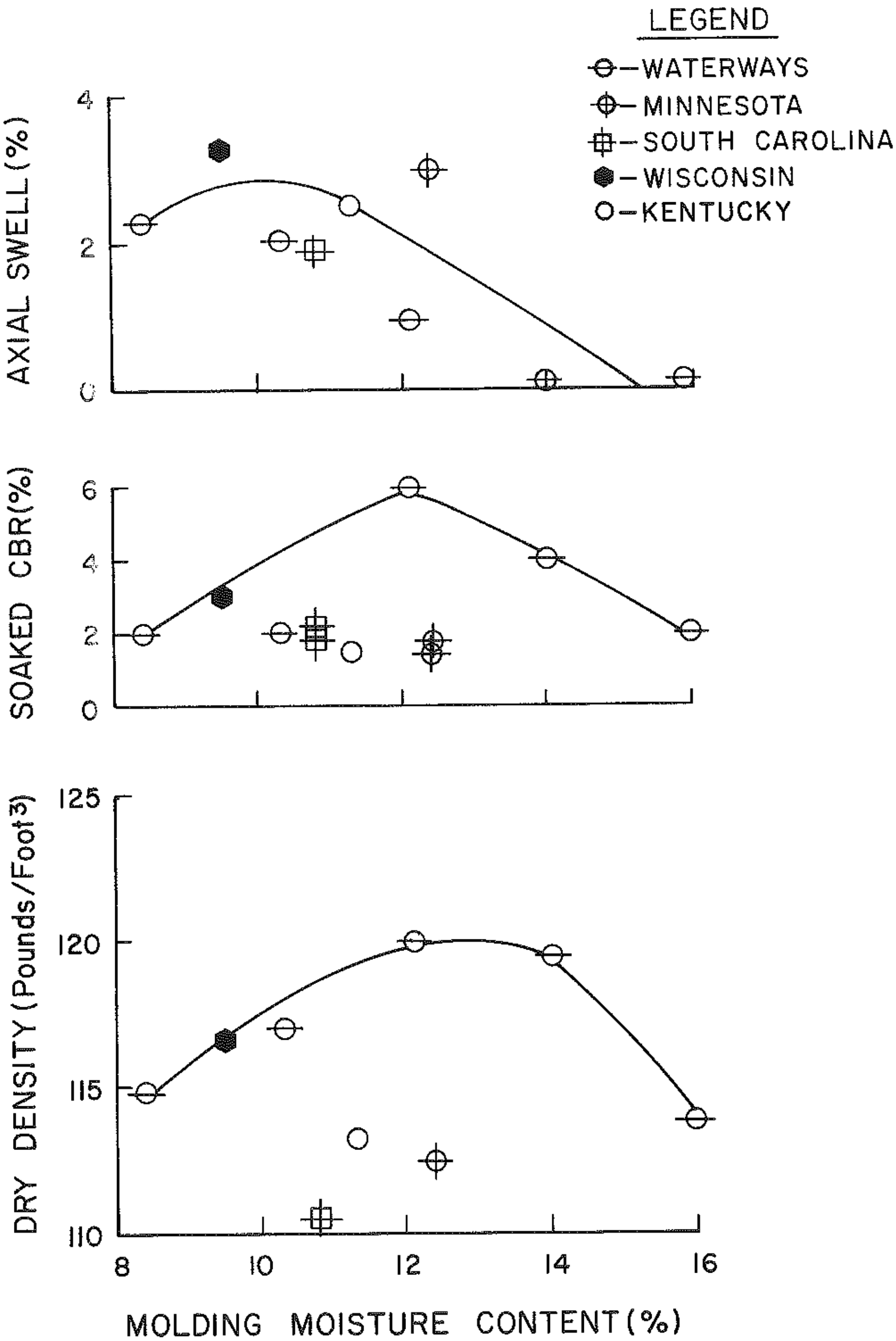


Figure 13. CBR Data, AASHO Soil Sample, Method 4 (12 blows/layer).

Figure 2 of this report are compared in Figure 9.

The CBR testing procedures of the Utah *(8)*, Oklahoma *(9)*, and Missouri *(10)* agencies are practically the same as Kentucky's method, although it is not exactly evident in any of the procedures which method of compaction is used to determine optimum moisture and maximum dry density; presumably each method refers to Methods 1 or 2, since "standard compaction" is commonly referred to in each of the procedures except Oklahoma's. Each of these agencies compact their CBR specimens under a static pressure of 2000 pounds per square inch. Note in Figure 9 that the reported Utah CBR value of 5.0 fits the Kentucky data; Oklahoma's CBR value is close, but Missouri's differs by about 3, mainly because of the relatively low dry density of the specimen. In a later report *(8)*, Utah correlated a dynamic CBR of 2.8 with a soil support of 3.

In the Illinois CBR procedure, the specimen is molded statically to a pre-determined optimum moisture content and maximum dry density derived in accordance with Method 1 or 2. Their reported CBR of 4 differs from the Kentucky value, although the dry density value fits close to the Kentucky moisture-dry density curve. This agency in a later report *(11)* shows a correlation between their CBR and soil support of 3 and 3, respectively.

Alabama's CBR procedure *(12)* specifies molding of at least three specimens at different moisture contents under a static load of 2000 pounds per square inch in order to determine three points on the moisture content-dry density curve. Using this curve, optimum moisture content and maximum dry density are determined. A CBR test is performed on a specimen molded at these conditions. As shown in Figure 9, their reported CBR of 4.5 is in fair agreement with the Kentucky value, although their dry density is higher. Information on New Jersey's CBR testing method was not available.

Considering that the above agencies perform the CBR test in varying manners, full reconciliation of the reported CBR data cannot be realized, although some of these data compare reasonably well with the Kentucky CBR data. The test data in Figures 2 and 9 establish a Kentucky CBR for the embankment soil at the AASHO Road Test site of 5.2.

In Figure 10, CBR data for specimens compacted in accordance with Method 2, reported by Shook and Fang *(2)*, and herein, Figure 2, are compared. Although there is some scatter of the data, notable trends are evident. For this compaction method, the CBR at optimum moisture content and maximum dry density appears to be 5.

Other CBR data reported by Shook and Fang *(2)* and herein for specimens compacted in accordance with Method 4 are shown in Figures 11 through 13. In Figures 12 and 13, the CBR data are for specimens molded with compactive energies of 24,992 and 11,992 foot-pounds per cubic foot while in Figure 11 the data are for specimens molded with 55,986 foot-pounds per cubic foot of energy. Again, notable trends are apparent. For the three compactive energies of 55986, 24992, and 11992 foot-pounds per cubic foot, CBR's of the AASHO soil appear to be 24, 12 and 6, respectively.

In Figure 14, three relationships between soaked CBR's, for different moisture-density relationships and different compactive energies are presented for the AASHO embankment soil. These curves are for 100, 98, and 95 percent compaction. Note that a 5-percent decrease in dry density produces a relatively large decrease in CBR's. Even a 2-percent decrease in dry density decreases the CBR's from 20 to 50 percent. The CBR values for the 98- and 95-percent compaction curves were on the "wet side of optimum moisture content." Generally, the "dry side" CBR values could not be read from the graphs in Figures 11 through 13.

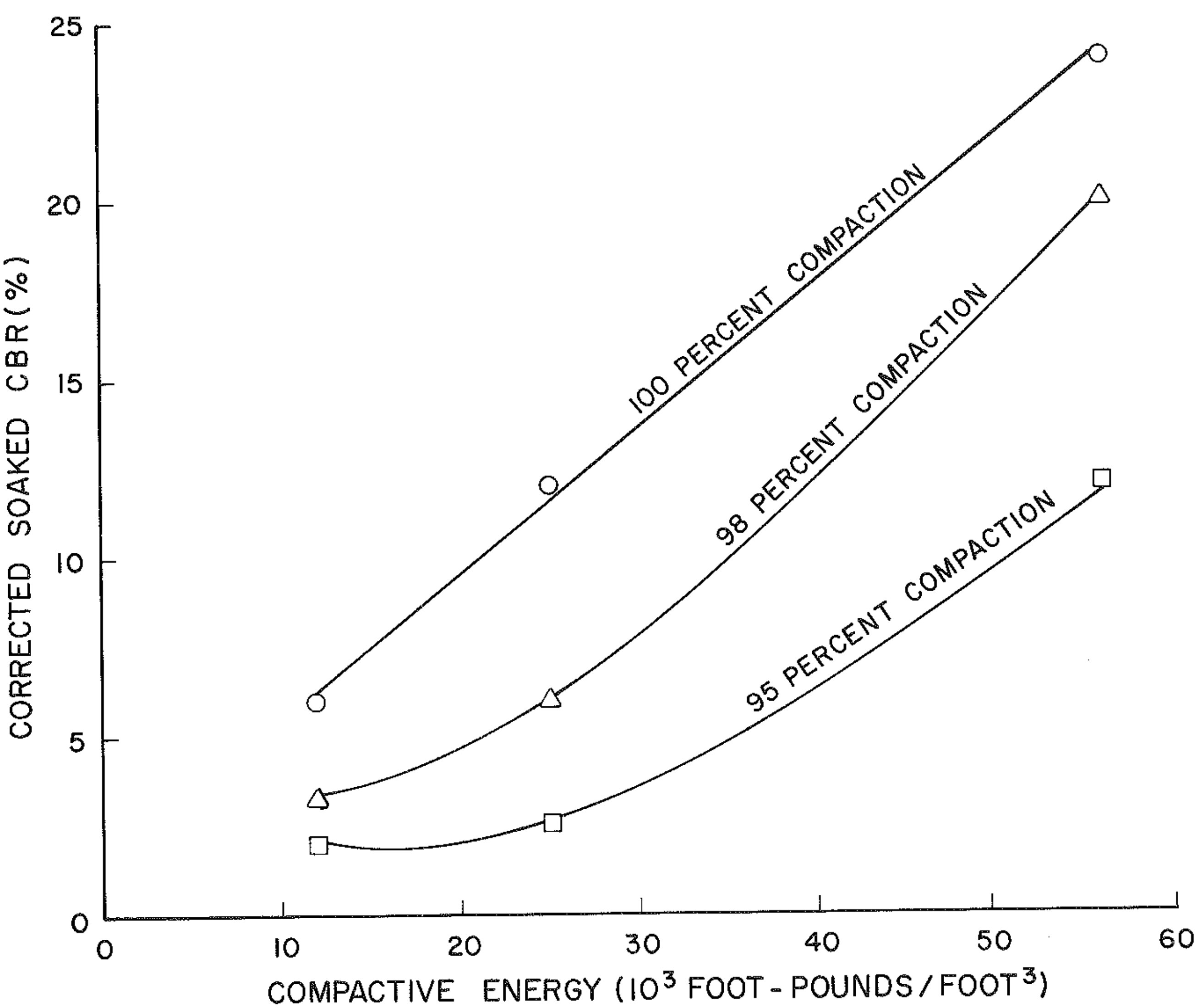


Figure 14. Corrected Soaked CBR - Compactive Energy Curves, AASHO Soil Sample.

KENTUCKY CBR-SOIL SUPPORT CORRELATION CURVES

The approach followed for modifying the results of the AASHO Road Test to permit their application and the establishment of pavement designs for other types of soils differing from the AASHO roadbed soils was similar to one suggested by the AASHO Committee on Design *(1)*. A series of Kentucky CBR tests were performed on soil samples obtained from a stockpile at the AASHO Road Test. From these data, a Kentucky CBR (5.2) was found to correspond to a soil support value of 3.0.

Crushed stone base material at the AASHO Road Test site having a soil support value of 10.0 was not available for determining a Kentucky CBR; consequently, a value had to be established by other means. In reviewing CBR data reported by Shook and Fang *(2)*, indications were that the crushed stone base material could be considered a "100 percent CBR material" for practical purposes. States such as Alabama, Illinois, Oklahoma and Utah, which used static compaction in preparing test specimens, reported CBR values of 145, 202, 200 and 180, respectively, although these states did not necessarily use these CBR's in their CBR-soil support correlation curves.

The Kentucky CBR-Soil Support Correlation Curve A, presented in Figure 15, was drawn by assuming a logarithmic scale between Kentucky CBR's of 5.2 and 100, corresponding to values on the soil support scale of 3 and 10, respectively. Correlation Curve B was constructed by assuming a logarithmic scale between Kentucky CBR's of 5.2 and 90 and soil support values of 3 and 10, respectively.

Kentucky CBR-Soil Support Correlation Curve C, Figure 15, was constructed in a manner described below. Using Kentucky equivalent wheel loads computed from actual traffic data from four loadometer stations in Kentucky, the Kentucky flexible pavement curves (Figure 21, APPENDIX E), and assuming various Kentucky CBR values, several pavement thickness designs were made (See Table 8 and sample calculations, APPENDIX E). For each pavement thickness determined in this manner, an unweighted structural number (SN) was calculated from the formula *(1)*,

$$SN = a_1d_1 + a_2d_2 + a_3d_3$$

where a_1, a_2, and a_3 = coefficients of pavement components (equivalency factors), and

d_1, d_2, and d_3 = thickness of bituminous surface course, base course, and subbase, respectively.

In Kentucky, a subbase course is not used in pavement design and consequently a_3d_3 equals zero. Values of a_1 of 0.36, a_2 of 0.18, d_1 of 3 inches, and d_2 equal to the total pavement thickness minus 3 inches were used in the equation to compute the structural numbers (SN). These values of a_1 and a_2 are currently used in pavement design in Kentucky *(13)*. The assumption of d_1 equal to 3 inches was a minimum thickness for a surface course suggested by Drake and Havens *(14)*.

From the actual traffic data, AASHO equivalent, daily, 18-kip axleload applications were computed. These computations produced six different values of equivalent 18-kip axleload applications since AASHO equivalency factors vary slightly in some cases *(1)* for SN values ranging from 1 to 6. For each structural number computed, which corresponded to an assumed Kentucky CBR, an equivalent 18-kip axleload application was interpolated from the computed AASHO equivalent loads determined above for SN values ranging from 1 to 6. Using this interpolated AASHO equivalent daily, 18-kip axleload application, the structural number obtained from the equation, and the AASHO design chart, Figure 20, APPENDIX E, (Serviceability index, P_t = 2.5), a soil support value corresponding to an assumed Kentucky CBR was obtained. For an assumed Kentucky CBR, soil support values varied as shown in Figure 16. Using an average value of the soil support values for each assumed Kentucky CBR, a curve was constructed

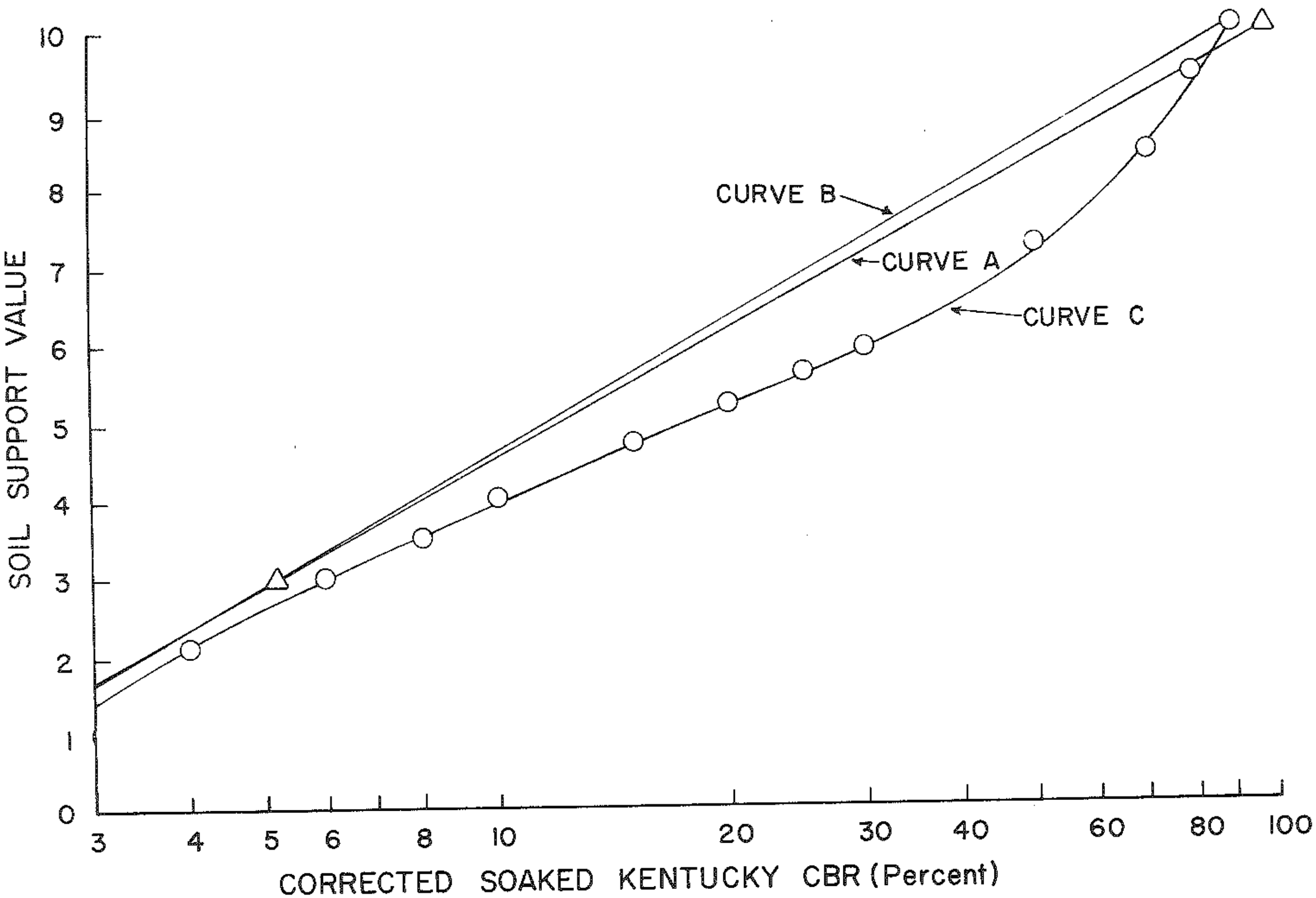


Figure 15. Soil Support Value - Corrected Soaked Kentucky CBR Correlation Curves A, B, and C.

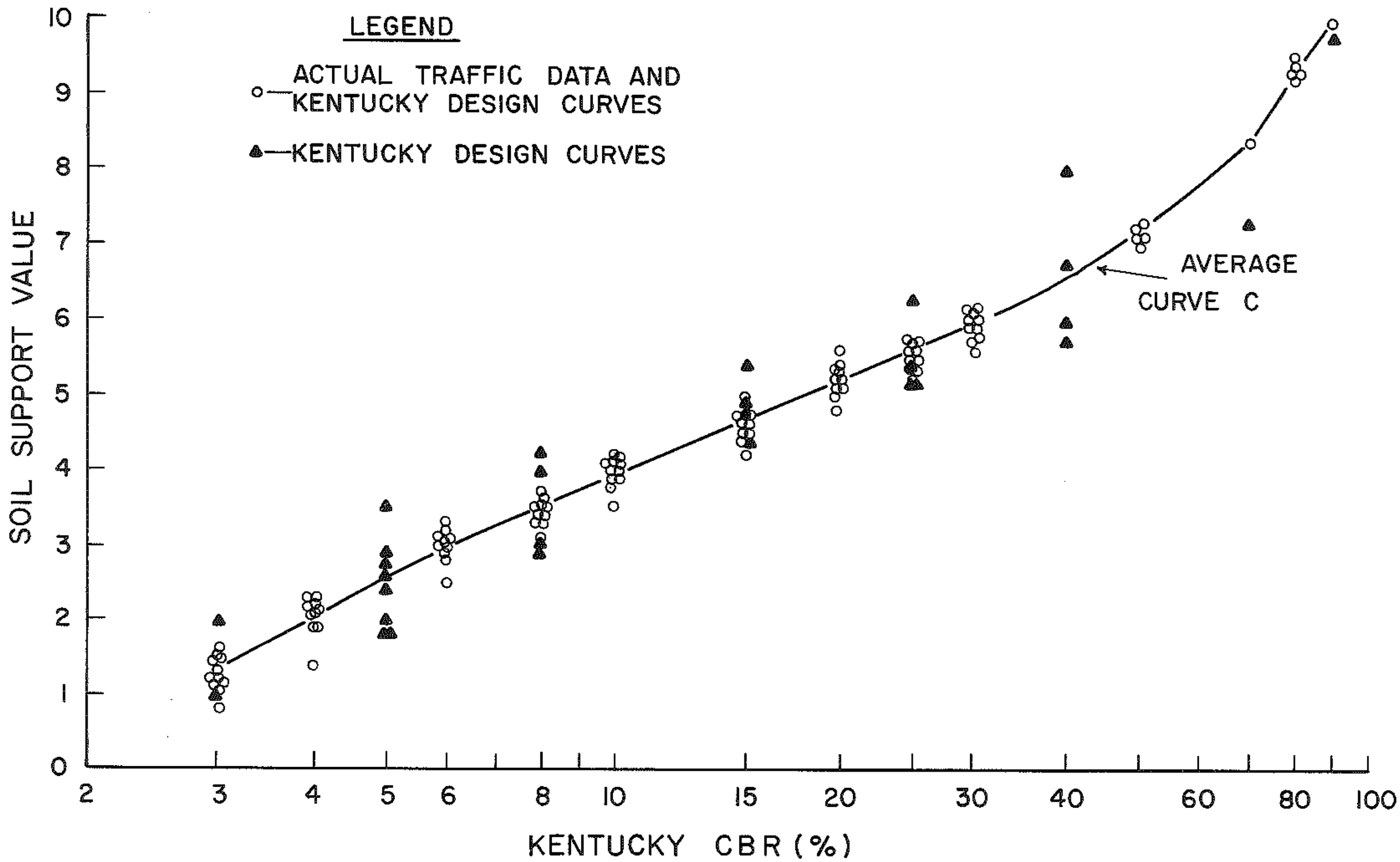


Figure 16. Soil Support Value - Kentucky CBR Curve C.

as shown in Figure 15 (Correlation Curve C). Note that a Kentucky CBR of 6 corresponds to a soil support value of 3, while tests established a Kentucky CBR of 5.2 for the AASHO roadbed soils. Hence, there was reasonable agreement in the results of the two methods used in establishing a Kentucky CBR for the AASHO roadbed soil.

Further verification of the relationship shown in Figure 16 was made as follows: A number of Kentucky CBR's covering the range from 3 to 90 were assumed. EWL's were also assumed for a broad range of traffic conditions representing Kentucky Design Curves I through X. The assumed EWL's were converted to AASHO equivalent daily, 18-kip axleload applications by dividing the product of 32 x 7300 (365 days x 20 years). Using the assumed Kentucky CBR's and EWL's and the Kentucky Flexible Pavement Design Curves, Figure 21, several combined pavement thicknesses were obtained. Typically, the thickness of Kentucky flexible pavements consists of one third bituminous concrete and two thirds granular base (dense graded aggregate). For ths particular ratio of thicknesses, the structural numbers for the pavement systems obtained above were computed using $a_1 = 0.44$ and $a_2 = 0.14$ and for $a_1 = 0.36$ and $a_2 = 0.18$. With these values of structural numbers and assumed EAL's, Figure 20 was used to determine values for the soil support corresponding to the appropriately assumed Kentucky CBR's. From Figure 16, it can be seen that the scatter resulting from such computations is somewhat greater than that obtained by the method described in Appendix E. Of course, it is recognized that this may be due, in part, to the fact that these computations represent a more complete range of traffic data and that the conversion of EWL's to EAL's by dividing by the factor of 32 is only an approximation. However, it is noted that Curve C does represent very adequately the relationship between soil support value and Kentucky CBR as obtained by both methods of calculation.

Nomographs constructed from the Kentucky CBR-Soil Support Correlation Curves A, B and C, Figure 15, are presented in Figure 17. Comparisons of several trial pavement designs were made using these nomographs, the AASHO Design Chart, and the Kentucky flexible pavement design charts (APPENDIX E). Actual traffic data were used and Kentucky CBR's of 8, 15 and 50 were assumed. The results of these computations are summarized in Table 11, APPENDIX F. As might be expected, Nomographs A and B yield about the same pavement thickness, while Nomograph C and the Kentucky Flexible Pavement Design curves yield approximately equal thicknesses. These data show that Nomographs A and B yield slightly thinner pavement sections than Nomograph C and the Kentucky curves.

DISCUSSION OF FINDINGS

Classification data, Table 2, for the AASHO Road Test sample secured from a stockpile at the AASHO site were practically the same as mean classification data reported by Shook and Fang *(2)*. The major differences were in the Atterberg limits. Mean liquid and plastic limits were 27.7 and 12.6 percent compared to 32.5 and 15.7 percent for the stockpile samples, respectively. Optimum moisture content and maximum dry density (Method 1) for the stockpile sample were 14.0 percent and 117.0 pounds per cubic foot compared to mean values of 13.5 percent and 119.2 pounds per cubic foot, respectively. Hence, the stockpile sample tested was essentially the same as used in the embankment at the AASHO Road Test site.

Molding CBR specimens statically under a 2000-pounds per square inch pressure and in a manner specified in the Kentucky CBR procedure Method 5, produces CBR specimens with higher initial dry densities, CBR's and axial swell values than those of specimens molded dynamically in accordance with Methods 2 or 3 as shown in Figures 2 through 7. For the soils tested, at optimum moisture content by Method 1, dry densities of specimens obtained by the Kentucky method (Method 5) ranged from about 3 to 10 percent higher than those obtained from Method 1, and they averaged about 6 percent higher.

In the range from about 4 to 12, Kentucky CBR and CBR's of specimens molded in accordance

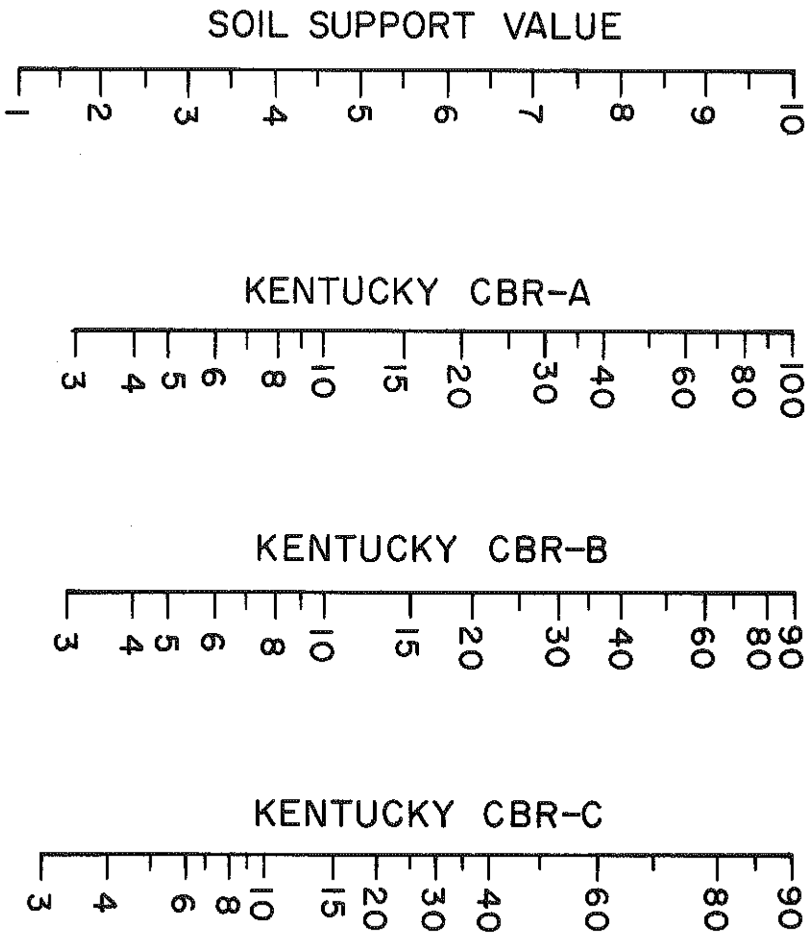


Figure 17. Soil Support Value - Kentucky CBR Nomographs A, B, and C.

with Method 2 were similar (see Figure 8). The comparatively higher axial swells associated with the Kentucky CBR's are apparently due partly to elastic rebound of the specimens, to the fact that the specimens are soaked until swell virtually ceases, and to the absence of shear strains during compaction.

In the Kentucky CBR tests, the maximum CBR did not occur at optimum moisture content and maximum dry density, but occurred slightly to the right ("wet side") of optimum moisture content. Maximum Kentucky CBR's generally occurred near the peak of the Method 1 molding moisture content-dry density curve. For the dynamically compacted samples, the maximum CBR usually occurred at optimum conditions.

Note in Figures 3 through 6 that for the Ohio sample, and Fayette, Clark, and Fulton County samples, Method 2 optimum moisture contents and maximum dry densities differ slightly from those obtained by Method 1. Method 2 maximum dry densities were slightly higher while optimum moisture contents were lower. In the case of Adair County, Figure 7, the maximum dry densities and optimum moisture contents for Methods 1 and 2 were about the same. For the AASHO Road Test sample, Figure 2, Method 1 maximum dry density was slightly higher than Method 2, but optimum moisture contents were about the same. In the case of the Adair County sample, Figure 7 maximum dry density and optimum moisture content were approximately the same. For samples molded in accordance with Method 3, dry densities were slightly lower, moisture contents higher and CBR's lower than those obtained by Method 2.

Molding the soil specimens in a manner specified in the Kentucky CBR method, but with varying moisture contents, generally produced smooth, orderly dry density-, CBR- and axial swell-molding moisture content curves. Exceptions were the series of tests on the Fulton County sample and, to a small degree, the Adair County sample. The dynamically compacted samples also generally produced smooth curves, except for the AASHO Road Test sample.

Influence of the method of compaction -- static and dynamic -- on CBR values is strongly indicated in Figure 4. In this series of tests, specimens were molded statically (not at 2000 pounds per square inch pressure) to conform with the dry density-molding moisture content curve obtained by Method 2. Static compaction pressures ranged from a high of 180 to a low of 99 pounds per square inch, much lower than the standard compaction pressure of 2000 pounds per square inch. CBR's obtained in this manner were as much as 40 percent lower than those resulting from Method 2.

Generally, for samples compacted at 2000 pounds per square inch, Kentucky CBR's were approximately the same or lower than CBR's of specimens molded by Method 2, although in two cases they were slightly higher. Kentucky CBR's averaged about 12 percent lower than Method 2 CBR's. The largest variation (Fulton County sample) was about 33 percent and an average variation for the soils from the six locations was 15 percent.

As reported by Shook and Fang *(2)*, average maximum densities and optimum moisture contents of the as-constructed embankment soil at the AASHO Road Test site were generally lower than those obtained from Method 1, and field CBR's were also lower. For "optimum construction", the embankment had a dry density of 117 pounds per cubic foot; while for Method 1 compaction, the dry density was 119. Hence, the "as-constructed" dry density was about 2 percent lower than Method 1 dry density. Note in Figure 14 that a 2 percent decrease in dry density resulted in a 20 to 50 percent decrease in CBR. For "P_{20} as constructed" (20th percentile, or density below which 20 percent of test valves lie, or moisture content above which 20 percent lie) a density of 112 pounds per cubic foot and a CBR of 2 was reported. The P_{20} field dry density was about 6 percent lower than Method 2 dry density and P_{20} field CBR of 2 was 60 percent lower than Method 2 CBR of 5. In Figure 14, a 5-percent decrease in dry density results in roughly a 50 to 60 percent decrease in CBR. Consequently, the apparent discrepancies between field and laboratory CBR's (dynamic compaction) are the result of differences in field and laboratory dry densities and moisture contents.

The two methods used in determining a Kentucky CBR of the AASHO Road Test soil produced similar results. From tests, a Kentucky CBR of 5.2 was obtained while computations produced a value of 6.0 -- a difference of about 15 percent.

CONCLUSIONS

Based on the findings presented herein, the following conclusions are summarized:

1. Nomographs C and D shown in Appendix A of the AASHO Guide *(1)* relating Kentucky CBR's and soil support values are not valid because the Kentucky CBR testing procedure does not contain provisions which permit the substitution of dynamic compaction in lieu of static compaction for molding CBR soil specimens.

2. In a range of about 4 to 12, Kentucky CBR's obtained from specimens molded in a manner specified in the Kentucky CBR testing procedure are roughly equal to CBR's of specimens molded at Method 2 optimum moisture contents and maximum dry densities.

3. Although initial dry densities of the Kentucky CBR specimens at Method 1 optimum moisture content were slightly higher than initial dry densities of specimens molded at optimum moisture content in accordance with Methods 1 or 2, final dry densities after swell for the Kentucky specimens were similar to Methods 1 or 2 final dry densities. For variable moisture contents, however, initial dry densities, CBR's and axial swell values were considerably higher for the Kentucky CBR specimens than those of Method 2.

4. For variable molding moisture contents and a given compaction procedure, final dry densities and moisture contents tend to be approximately the same after soaking, although CBR's vary considerably at different molding moisture contents.

5. Soil specimens molded under static pressure and at different moisture contents yield dry density and CBR-molding moisture contents which are similar in shape (parabolical) to those obtained by dynamic compaction.

6. Apparently, the method of compaction -- static and dynamic -- results in significantly different CBR's. For soil specimens molded at the same initial dry densities, CBR's of statically compacted specimens are distinctively lower than those observed for dynamically compacted specimens.

7. Dynamic and static compaction methods affect the magnitude of axial swell and apparently the time duration for axial swell to virtually cease in differing degrees. For specimens compacted statically under a 2000-pound per square inch pressure, the magnitude of axial swell was considerably more than for specimens compacted dynamically by Method 2. Time required for axial swell to virtually cease for the statically compacted specimens appeared to be greater than the time observed for dynamically compacted specimens.

8. For relatively small decreases in initial dry densities, there were very large decreases in CBR's. This probably accounts for discrepancies that have been observed between field and laboratory CBR's.

9. Reasonable agreement was obtained between the Kentucky CBR of 5.2 obtained from a series

of CBR tests and the Kentucky CBR of 6.0 derived from computations for the AASHO Road Test embankment soil.

10. The nomographs relating Kentucky CBR's and soil support values and presented herein appear to yield reasonable values of pavement thicknesses.

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APPENDIX A

KENTUCKY CBR TEST PROCEDURE

LABORATORY PROCEDURE FOR DETERMINING CBR
(As Revised by Kentucky Department of Highways)

SCOPE

1. The CBR (California Bearing Ratio) is the percentage ratio between the load-beraing values of subgrade soil or base material and that of an idealized base material normally represented as well as graded, uncemented, crushed rock. Typical values of stress and deformation have been established for the reference material. Thus, when samples of material are tested in accordance with the following procedure, the CBR is given as the ratio between the measured stress and an idealized stress at designated magnitudes of deformation. The procedure provides that the samples shall be prepared at optimum moisture, compacted under a static load of 2,000 psi, and subsequently soaked, by total immersion, until the virtual cessation of swelling under a designated surload.

APPARATUS

2. (a) *Hollow Cylinder Mold.* The mold shall be a cylinderical pipe section, 6 inches inside diameter and 7 inches in height, and shall be securely attached to a rigid base plate in such a manner that the cylinder may be easily detached, inverted, and reattached.

(b) *Compacting Plunger.* The plunger shall be 5 inches in height and approximately 5.90 inches in diameter, shall have smooth, flat end surfaces, and shall be capable of withstanding an axial static load of 60,000 pounds.

(c) *Apparatus for Measuring Swelling.* A perforated rigid plate approximately 5.90 inches in diameter and having an axial, threaded stud approximately 3 inches in length and ¼ inch in diameter, with screw cap and lock nut, extending from one side, and annular weights sufficient to provide a 15-pound surload on the perforated plate shall provide, when seated firmly upon the compacted speciman in the mold, a point for measuring changes in height of the specimen during soaking. Height measurements shall be made by means of a depth gage consisting of a dial micrometer mounted stem downward on a tripod such that the legs of the tripod will rest upon the top rim of the mold and the micro-meter stem will contact the adjustable screw-cap and thus permit measurements of changes in elevation of the perforated plate with respect to a datum.

(d) *Loading Cylinder.* The test load shall be applied to the specimen through a solid-right cylinder, approximately 7.5 inches in height and having an end area (bearing area) of 3 square inches (1.954 inches in diameter).

(e) *Testing Machine.* A laboratory testing machine, consisting of a hydraulic press or screw jacks, capable of delivering a load of 60,000 pounds, and capable of imparting a constant rate of travel of 0.05 inches per minute to the ram or loading platen and appropriate load measuring devices.

(f) *Annular Weights.* Annular weights, having approximately 5.90 inches outside diameter and 2.12 inches inside diameter, sufficient to provide a 15 pound surload upon the specimen during the application of the test load.

(g) *Filter Paper.* Coarse filter paper approximately 6 inches in diameter.

(h) *Miscellaneous Apparatus.* Other general laboratory equipment such as mixing bowls, spatulas, weighing scales, soaking tank, drying oven, containers for moisture-content samples, etc.

PREPARATION OF SPECIMEN

3. The sample of the material to be tested shall be air dried until it is friable and then shall be disaggregated thoroughly and in such manner as to avoid crushing discrete particles. An adequate quantity of the material shall be selected and those particles larger than 3/4 inches and the portions between 3/4 inches and 3/8 inches and between 3/8 inches and the No. 4 sieve shall be separated from it. That portion larger than 3/4 inches shall be discarded and an equal portion of the 3/4 inches to 3/8 inches fraction substituted therefore. However, if the percentage of material discarded is large in comparison to the 3/4 inch to 3/8 inch portion, the 3/4 inch to 3/8 inch portion and the 3/8 inch to No. 4 portion may be combined and an equal portion of the 3/4 inch to the No. 4 sieve sizes may be substituted for it. The recombined sample shall then consist of the original percentages passing the No. 4 sieve, between the No. 4 and 3/8 inch, and between 3/8 inch and 3/4 inch and a subsitute percentage of either 3/4 inch to 3/8 inch or 3/4 inch to No. 4 sizes. A sufficient quantity of the reconstituted air-dry sample to fill the 6-inch diameter mold to a height of 5 inches (0.074 cubic foot) when compacted at optimum moisture content and maximum density (air-dry weight of sample calculated from maximum dry density in pounds per cubic foot as determined by Proctor density tests multiplied by 0.074 cubic foot) shall be weighed and thoroughly mixed with an optimum amount of water giving the maximum, calculated, dry density upon compaction (may be estimated from the optimum percent moisture as determined by Proctor density tests by substracting the percentage of hygroscopic moisture, as determined from the minus No. 4 fraction, and multiplying by the percent of minus No. 4 material in the reconstituted soil, then adding 3 percent, by weight of the plus No. 4 fraction, to provide an allowance of moisture to wet the coarse particles). The moist soil shall be placed in the mold and tamped lightly to provide a smooth surface. The compacting plunger shall be inserted and the specimen loaded to 2000 psi within an interval of two minutes and sustained for a minimum period of one minute, after which the load is gradually released and the plunger removed. The surface of the specimen shall be covered with a 6-inch diameter filter paper, the mold shall be inverted, and the specimen compacted as before. Upon subsequent removal of the plunger, the height of the compacted specimen shall be measured to the nearest 0.01 inch, and the dry density calculated from the dry weight of sample and its compacted volume (wet density may also be determined from the weight of sample and its volume).

EXPANSION (SWELLING)

4. A 6-inch diameter filter paper shall be placed over the exposed surface of the specimen and the perforated plate placed thereon. The 15-pound surload weight shall be placed on the plate, the tripod-mounted dial micrometer placed on the rim of the mold, and the elevation of the screwcap adjusted to a zero or to a reference reading on the dial (nearest 0.001 inch). The tripod assembly shall be removed and the sample immersed in water to a depth at least sufficient to cover the rim of the mold. Micrometer measurements shall be taken daily until the expansion ceases, i.e., until successive dial measurements of height do not differ by more than 0.003 inches (minimum of 72 hours).

LOAD BEARING TEST

5. Following the soaking period, the mold shall be thoroughly drained, the 15-pound surload, perforated plate, and filter paper removed, and the mold assembly placed in the testing machine. A 5-pound surload weight shall be placed on the surface of the specimen, and the loading cylinder placed uprightly and centered on the surface of the specimen exposed through the hole in the weight. A token load of approximately 10 pounds may be applied to the cylinder in order to seat it against the specimen and the head plate of the testing machine. Both stress and strain gages shall be set to zero, and the load applied so that the rate of penetration of the cylinder into the specimen is 0.05 inch per minute. Load readings shall be obtained when the depth of penetration has proceeded to 0.010, 0.025, 0.05, 0.075, 0.10. 0.20, 0.30, 0.40, and 0.50 inch.

DETERMINING MOISTURE CONTENT

6. Upon completion of the load-bearing test, a sample of the specimen immediately under the loading cylinder and to a depth of approximately 1 inch shall be removed, weighed, and dried at 110°C, to a constant weight. Likewise, the moisture content of the entire remainder of the specimen shall be determined by drying to a constant weight.

CALCULATION OF BEARING RATIO

7. The bearing ratio shall be calculated by expressing the stress (load in pounds/square inches), at each depth of penetration, as a percentage of the following respective standard reference stress values:

Penetration (inches)	Standard Reference Stress (psi)
0.1	1000
0.2	1500
0.3	1900
0.4	2300
0.5	2600

Note: Since the initial readings of load and penetration are frequently disproportional, due to irregularities in the surface or in distribution of moisture near the surface, it is usually necessary to plot a graph of stress versus depth of penetration (ordinate and abscissa, respectively) and to correct the abscissa for any concave-upward tendency in the section of the curve near the origin, as illustrated in Figure 18.

REPORT

8. The report shall include the CBR values calculated for each 0.1-inch depth of penetration, moisture contents of the specimen at the time of test, percent swell (by volume), and the percent of Proctor density before and after soaking.

Note: Originally, the CBR value selected for design purposes was taken at 0.1-inch penetration. However, experience has shown that the CBR's of granular materials tend to increase with depth of penetration, while those from clay soils may decrease. The CBR selected for use with the Kentucky criterion for design of pavement thicknesses shall be the minimum value.

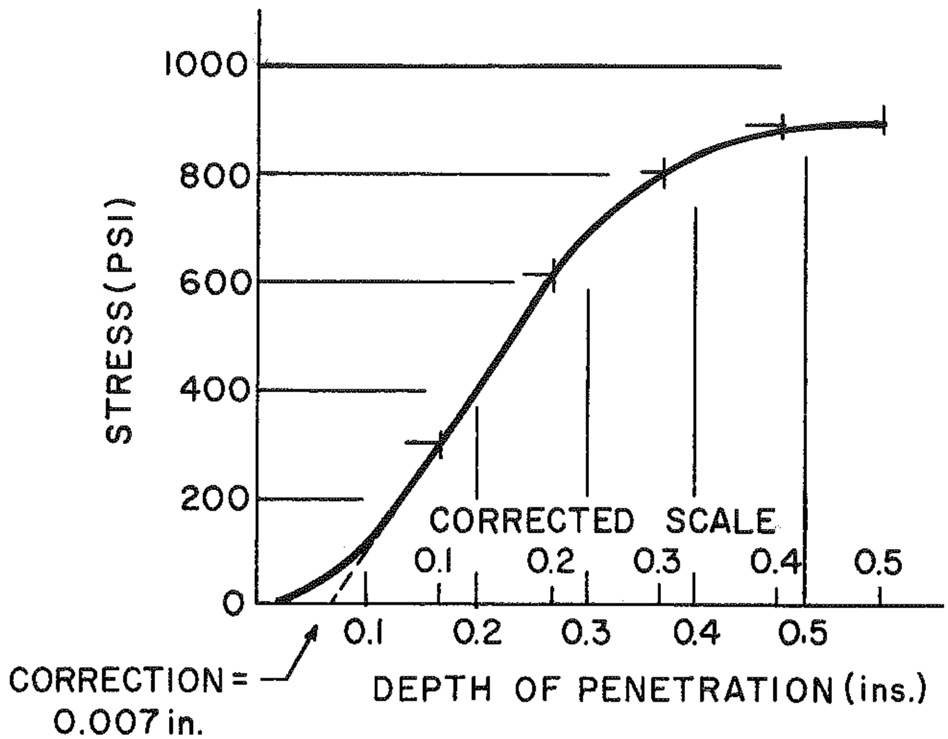


Figure 18. Example of Suggested Method for Correcting Stress-penetration Curves to Obtain True Values of Stress and Depth of Penetration to be Used in Computing CBR's.

APPENDIX B

CLASSIFICATION DATA

TABLE 2: SUMMARY OF CLASSIFICATION DATA

Soil Sample	Location	Classification			Atterberg Limits		Moisture-Density Relationship (AASHO T-99)		Grain Size Distribution (Percent finer)							Specific Gravity
		AASHO	Unified	Textural	Liquid Limit	Plasticity Index	Optimum Moisture Content (Percent)	Maximum Density (Lbs/cu.ft.)	No. 4	No. 40	No. 200	0.05 MM	0.02 MM	0.005 MM	0.002 MM	
AASHO Road Test (Mean Values from Ref. 2)	AASHO Road Test Site	A-6(9)	CL	Clay	27.7	12.6	13.5	119.2	96.6	88.6	75.5	72.3	61.9	40.3	27.6	2.72
AASHO Road Test (Kentucky)	AASHO Road Test Site	A-6(11)	CL	Clay	32.5	15.7	14.0	117.0	97.0	90.0	79.5	76.5	65.5	45.0	32.0	2.68
Ohio	Ohio	A-6(8)	CL	Clay Loam	30.0	12.0	16.8	111.7	95.0	86.0	71.0	58.0	45.0	30.0	21.0	2.71
Fayette County (Maury Series)	225 feet from US 60 on Van Meter Road	A-6(12)	CL	Clay Loam	34.5	13.5	19.8	100.5	100.0	94.0	79.0	76.0	61.0	30.0	20.0	2.69
Clark County (Eden Series)	275 feet South of Winchester City Limits on Ky 89	A-6(13)	CL	Silty Clay	36.5	12.0	21.5	98.6	100.0	98.0	91.0	88.0	75.0	44.0	31.0	2.71
Fulton County (Calloway Series)	1500 feet North of Ky 94 and State Line Intersection	A-4(8)	ML	Silt Loam	26.1	1.0	16.6	107.3	100.0	98.0	78.0	70.0	40.0	17.0	13.0	2.66
Adair County (Baxter Series)	Intersection of Ky 55 and 633	A-7-5(19)	CH	Clay	61.0	34.0	24.0	96.2	92.3	89.3	87.6	82.0	74.0	58.0	50.0	2.77

APPENDIX C

SUMMARY OF KENTUCKY CBR DATA

SUMMARY OF ASTM CBR DATA

SUMMARY OF ASTM CBR DATA (SAMPLE HEIGHT 5 INCHES)

MISCELLANEOUS CBR DATA

TABLE 3: SUMMARY OF KENTUCKY CBR DATA

Location	Test Number	As Molded		Axial Swell (Percent)	Swell Time (Days)	After Soaking		CBR (Percent) Penetration (Inches)					Degree of Saturation		Void Ratio	
		Moisture Content (Percent)	Dry Density (Lbs/cu.ft.)			Moisture Content (Percent)	Dry Density (Lbs/cu.ft.)	0.1	0.2	0.3	0.4	0.5	Before Soaking (Percent)	After Soaking (Percent)	Before Soaking	After Soaking
AASHO	1	7.7	127.7	7.7	18.0	15.8	118.6	3.7	3.6	3.5	3.5	3.5	66.6	100.0	0.310	0.411
	2	5.4	125.7	7.1	18.0	16.4	117.4	2.6	2.5	2.5	2.5	2.6	43.6	100.0	0.331	0.425
	3	14.0	123.5	4.6	18.0	16.9	118.0	5.5	5.4	5.3	5.2	5.2	100.0	100.0	0.355	0.417
	4	10.4	128.6	7.3	17.8	15.4	119.8	4.7	4.9	4.9	4.9	4.9	92.5	100.0	0.300	0.396
	5	11.4	128.9	6.5	12.0	15.2	121.1	4.8	5.1	5.2	5.2	5.4	100.0	100.0	0.298	0.382
	6	17.0	116.9	1.8	6.0	18.2	114.8	4.2	4.0	3.9	3.7	3.6	100.0	100.0	0.431	0.456
	7	9.9	130.7	8.6	9.7	14.9	120.4	3.7	4.4	4.7	4.9	5.0	91.8	89.9	0.245	0.353
	8	13.8	125.3	4.0	6.9	15.9	120.5	5.3	5.5	5.5	5.4	5.4	94.6	100.0	0.295	0.336
Ohio	1	14.3	120.3	2.7	10.7	16.8	117.2	9.7	9.6	9.4	9.0	8.6	100.0	100.0	0.432	0.471
	2	7.4	125.4	7.1	10.6	17.2	115.2	3.7	4.0	4.1	4.2	4.2	53.6	99.6	0.370	0.467
	3	9.4	123.9	7.3	10.8	16.7	115.5	3.7	4.2	4.3	4.3	4.4	69.3	97.6	0.366	0.465
	4	12.1	125.4	4.4	10.8	15.5	120.2	7.0	7.5	7.4	7.2	7.3	94.2	100.0	0.348	0.406
	5	13.8	123.6	2.7	10.0	15.6	120.3	8.0	7.7	7.4	7.0	6.9	100.0	100.0	0.368	0.405
	6	10.4	127.5	5.6	10.0	14.7	120.8	6.2	6.6	6.7	6.6	6.7	86.2	99.7	0.327	0.401
	7	12.8	123.9	4.0	10.0	15.5	119.1	8.4	8.6	8.4	8.1	8.2	95.3	100.0	0.365	0.420
	8	11.9	126.4	4.7	17.0	16.3	120.7	7.1	7.7	7.7	7.6	7.7	99.0	100.0	0.348	0.412
	9	15.6	118.8	2.3	6.9	17.3	116.1	6.3	6.4	6.2	5.8	5.6	40.6	49.7	0.284	0.314
	10	10.7	126.6	5.9	11.9	15.1	119.6	5.7	6.4	6.7	6.8	7.1	78.2	92.7	0.318	0.396
	11	17.3	115.2	2.0	7.8	18.6	113.3	6.1	5.4	5.2	4.8	4.7	93.9	95.5	0.438	0.466
	12	13.7	123.4	3.5	7.0	16.1	119.3	7.9	8.1	7.9	7.7	7.8	93.2	98.2	0.349	0.396
	13	17.2	114.5	2.0	5.9	18.5	112.3	5.7	5.2	4.8	4.5	4.4	98.8	99.4	0.473	0.503
	14	15.8	117.6	2.5	5.9	17.3	114.8	7.2	6.8	6.5	6.2	6.2	98.4	99.7	0.435	0.471
Fayette	1	10.0	114.5	4.2	10.0	19.0	109.9	11.3	11.2	10.6	10.1	10.2	56.9	96.9	0.464	0.525
	2	12.4	116.9	3.4	7.0	17.3	113.0	13.1	13.5	13.2	12.6	12.0	76.7	96.2	0.433	0.482
	3	15.7	116.3	2.3	7.0	17.6	113.7	15.7	14.9	14.1	13.5	13.5	95.5	99.6	0.441	0.474
	4	21.4	108.7	3.0	6.8	23.8	105.5	10.1	10.2	9.9	9.5	9.7	100.0	100.0	0.542	0.588
	5	24.3	103.9	1.4	5.8	25.8	102.5	8.8	8.0	7.5	6.9	6.8	100.0	100.0	0.612	0.634
	6	26.6	99.9	1.3	6.7	27.7	98.7	5.8	5.2	4.8	4.5	4.4	100.0	100.0	0.677	0.699
	7	29.6	96.0	1.3	6.9	30.3	94.8	3.1	2.8	2.5	2.3	2.2	100.0	100.0	0.745	0.768
	8	18.5	112.1	1.5	3.8	19.4	110.4	9.1	8.2	7.8	7.3	7.2	97.4	97.6	0.482	0.505
Clark	1	11.7	116.4	5.9	10.8	20.4	110.0	5.9	7.1	7.5	7.6	8.0	70.6	100.0	0.450	0.534
	2	16.8	111.9	7.2	5.8	24.1	104.4	6.5	7.6	8.1	8.1	8.7	88.8	100.0	0.510	0.687
	3	12.0	108.9	8.5	9.8	25.1	102.8	5.5	6.0	6.2	6.2	6.5	59.7	99.7	0.550	0.682
	4	21.9	108.0	5.1	5.8	25.4	102.8	6.7	8.0	8.3	8.3	8.6	100.0	100.0	0.562	0.641
	5	6.6	110.0	8.4	14.8	23.0	101.5	4.9	5.2	5.3	5.2	5.4	33.3	94.1	0.534	0.662
	6	22.2	103.3	3.8	10.9	25.0	102.0	5.7	5.4	5.1	4.8	4.5	78.4	88.4	0.517	0.575
	7	24.4	96.8	1.5	11.9	27.2	89.5	1.8	1.7	1.7	1.6	1.6	74.3	82.4	0.655	0.680
	8	24.2	94.9	0.6	12.0	26.9	94.4	2.0	2.0	1.9	1.9	2.0	70.8	79.6	0.690	0.700
	9	25.5	96.5	1.2	11.9	27.8	95.4	1.8	1.8	1.8	1.8	1.8	77.8	84.2	0.657	0.677
	10	22.3	103.1	2.5	12.0	25.1	100.7	3.7	3.9	3.9	3.8	3.8	79.3	86.3	0.557	0.596
	11	20.8	106.5	2.8	5.9	23.1	103.9	6.8	6.8	6.7	6.4	6.5	78.6	84.0	0.504	0.542
	12	21.5	104.5	3.7	5.8	22.8	100.8	6.4	6.7	6.6	6.3	6.3	79.4	78.9	0.732	0.783
	13	9.3	115.5	9.1	6.9	20.9	111.1	5.4	6.1	6.5	6.7	7.1	44.7	89.5	0.565	0.631
	14	19.4	109.0	4.4	5.8	22.5	104.6	7.1	7.5	7.5	7.5	7.9	79.2	83.0	0.661	0.733
Fulton	1	11.2	106.6	2.2	6.9	21.0	104.3	7.0	8.6	9.3	10.0	10.6	53.3	94.5	0.554	0.589
	2	11.3	108.0	2.6	9.7	20.5	105.2	8.0	8.4	8.8	9.0	9.7	59.6	92.4	0.550	0.591
	3	20.0	104.9	0.1	6.9	21.7	104.7	6.3	8.2	8.1	8.2	8.8	91.7	98.8	0.582	0.584
	4	14.9	110.0	1.7	7.0	17.6	108.3	10.0	11.8	12.3	12.6	14.1	74.9	89.5	0.500	0.523
	5	17.0	109.4	1.5	5.9	18.6	107.8	9.0	10.9	11.2	11.3	11.8	87.5	91.6	0.516	0.539
	6	16.9	111.4	1.8	5.9	18.3	109.5	10.7	13.3	14.0	14.3	15.3	92.0	94.6	0.488	0.514
	7	12.1	110.3	1.7	7.0	17.7	108.5	16.0	15.1	14.7	14.9	15.8	63.9	88.9	0.503	0.528
	8	18.8	111.6	1.5	5.8	19.2	110.1	15.0	17.1	18.4	19.1	19.9			0.485	0.506
	9	13.6	111.5	1.6	3.0	15.2	109.9	5.8	7.2	7.7	8.2	9.2	74.4	79.4	0.484	0.507
Adair	1	16.5	115.0	10.1	24.0	22.9	104.9	3.9	3.9	3.9	3.9	3.9	91.0	96.8	0.502	0.654
	2	13.0	114.5	13.1	21.0	24.1	101.3	3.9	3.8	3.7	3.6	3.6	70.6	94.4	0.508	0.706
	3	15.4	116.0	10.4	24.0	22.1	105.1	5.3	5.5	5.8	5.8	5.8	87.1	95.1	0.488	0.643
	4	9.5	111.8	12.0	13.0	24.8	99.9	3.1	3.0	2.8	2.8	2.8	48.7	94.2	0.544	0.729
	5	23.3	103.4	3.8	13.1	25.7	99.6	6.7	6.0	5.5	5.1	4.9	96.2	96.7	0.670	0.734
	6	20.1	109.1	7.1	17.0	24.1	101.9	4.5	4.5	4.5	4.3	4.3	95.2	95.8	0.583	0.696
	7	20.1	109.3	6.3	13.8	23.9	102.9	6.1	5.8	5.7	5.5	5.4	96.0	97.2	0.580	0.679
	8	26.3	99.9	2.5	6.8	27.8	97.5	6.8	6.0	5.5	5.3	5.1	99.9	99.9	0.729	0.772
	9	21.0	107.5	5.9	10.0	24.5	101.5	4.9	4.8	4.7	4.5	4.5	95.8	96.6	0.607	0.702
	10	24.4	97.0	1.1	7.7	29.1	96.0	5.8	5.2	4.7	4.3	4.2	86.5	100.0	0.781	0.799
	11	17.9	114.1	9.7	10.0	23.6	104.0	4.3	4.2	3.9	3.6	3.8	96.4	98.8	0.514	0.661
	12	23.1	105.0	4.3	6.9	25.7	100.7	5.7	5.3	5.1	4.9	4.9	99.1	99.5	0.645	0.715
	13	25.4	101.1	4.0	6.6	26.9	97.5	5.4	5.2	4.9	4.6	4.5	99.7	96.4	0.705	0.772
	14	26.1	98.8	3.0	8.6	27.8	93.0	4.5	3.9	3.6	3.4	3.3	96.6	89.8	0.748	0.857

TABLE 4: SUMMARY OF ASTM CBR DATA

Location	Test Number	As Molded Moisture Content (Percent)	As Molded Dry Density (Lbs/cu.ft.)	Axial Swell (Percent)	Swell Time (Days)	After Soaking Moisture Content (Percent)	After Soaking Dry Density (Lbs/cu.ft.)	CBR (Percent) Penetration (Inches) 0.1	0.2	0.3	0.4	0.5	Degree of Saturation Before Soaking (Percent)	Degree of Saturation After Soaking (Percent)	Void Ratio Before Soaking	Void Ratio After Soaking
AASHO	1	17.1	108.6	0.6	3.9	18.6	108.4	2.7	2.5	2.6	2.6	2.7	84.5	92.0	0.540	0.543
	2	16.1	107.6	0.7	3.9	19.3	106.8	2.2	2.0	1.9	1.9	1.9	77.2	91.4	0.557	0.565
	3	11.7	114.5	0.8	3.8	13.7	114.1	2.7	2.7	2.8	2.8	2.9	67.9	78.6	0.463	0.467
	4	15.4	109.9	1.2	3.8	18.6	110.4	1.1	1.2	1.4	1.6	1.8	79.7	93.4	0.517	0.534
	5	14.1	112.0	1.8	3.8	18.0	110.2	1.4	1.6	1.7	1.9	2.1	76.1	92.9	0.495	0.519
	6	13.2	112.4	2.4	3.9	18.6	112.4	2.1	2.1	2.2	2.2	2.2	72.4	94.6	0.491	0.527
	7	10.9	110.2	3.3	4.0	20.7	106.7	0.4	0.5	0.5	0.5	0.6	56.3	97.6	0.518	0.568
	8	12.6	111.9	2.6	3.0	18.3	109.1	1.6	1.7	1.8	1.8	1.8	68.3	92.1	0.495	0.533
	9	13.8	110.1	2.2	3.9	19.1	107.7	0.5	0.5	0.6	0.7	0.8	71.1	92.7	0.520	0.553
	10	15.5	110.8	1.3	3.9	18.9	109.4	1.3	1.4	1.7	1.8	2.0	78.3	95.6	0.509	0.529
	11	12.1	111.7	2.9	3.9	19.5	108.6	1.0	1.1	1.1	1.2	1.3	65.1	96.5	0.497	0.540
	12	15.0	113.6	1.2	2.9	17.0	111.4	3.8	4.0	4.1	4.2	5.3	85.7	91.5	0.474	0.502
	13	9.0	106.9	3.8	3.0	21.7	102.9	0.4	0.4	0.5	0.5	0.5	42.4	93.0	0.565	0.625
	14	14.4	110.7	1.3	4.0	18.8	109.6	1.8	1.8	2.0	1.9	2.1	75.0	95.9	0.513	0.526
	15	10.4	108.2	3.1	4.0	20.3	105.0	0.7	0.8	0.8	0.9	0.9	51.0	92.0	0.545	0.593
	16	6.8	107.3	3.3	4.0	22.1	103.9	0.6	0.6	0.6	0.6	0.6	32.5	97.0	0.559	0.610
	17	13.8	110.1	2.0	4.0	19.4	108.5	1.8	1.9	2.1	2.1	2.2	70.7	100.0	0.336	0.362
	18	14.0	109.4	1.8	4.0	19.2	108.0	0.7	0.7	0.8	1.1	1.1	70.8	92.6	0.529	0.556
	19	15.4	111.8	2.9	4.0	18.2	110.9	2.6	3.4	3.1	3.1	3.2	83.0	90.5	0.497	0.540
	20	13.1	111.4	2.9	3.0	16.5	108.3	0.8	0.7	0.8	0.8	0.9	69.8	88.7	0.504	0.500
	21	15.1	116.3	0.8	4.0	16.6	116.0	5.0	5.6	5.7	5.6	5.7	92.6	100.0	0.436	0.439
	22	14.8	113.5	1.2	4.0	18.0	111.6	3.8	4.1	4.2	4.1	4.2	83.8	91.0	0.474	0.499
Ohio	1	12.8	113.6	1.9	4.0	17.9	111.4	2.5	2.8	3.0	3.2	3.5	71.5	93.9	0.491	0.520
	2	17.7	109.9	0.3	4.0	18.5	109.6	2.0	2.4	2.5	2.5	2.6	88.9	92.4	0.539	0.543
	3	15.0	114.4	1.1	4.0	17.2	113.1	5.8	6.0	6.2	6.2	6.5	84.7	94.1	0.479	0.495
	4	9.4	110.0	3.3	4.0	20.0	106.6	1.3	1.3	1.4	1.4	1.3	47.5	92.2	0.537	0.587
	5	12.0	108.9	2.6	4.0	20.1	106.2	1.4	1.5	1.6	1.7	1.8	59.2	91.5	0.554	0.594
	6	12.9	108.9	2.6	4.0	19.4	106.3	1.6	1.7	1.8	2.0	2.3	63.7	88.5	0.553	0.592
	7	16.0	111.6	0.9	3.0	17.9	108.8	7.1	6.7	6.4	6.1	6.0	84.8	92.4	0.512	0.526
	8	15.3	114.4	1.1	3.0	17.0	111.8	8.0	8.3	8.3	8.1	8.1	87.5	97.3	0.475	0.472
	9	14.5	110.8	2.1	3.9	19.3	107.9	2.3	2.4	2.5	2.6	2.8	75.2	92.5	0.524	0.564
Fayette	1	16.4	104.9	1.2	4.0	20.9	103.8	5.4	5.3	5.4	5.3	5.3	73.0	90.1	0.604	0.623
	2	19.6	103.9	0.5	4.0	21.1	103.4	3.1	3.6	3.9	3.9	3.9	85.0	89.9	0.620	0.628
	3	17.5	106.2	0.8	4.0	19.9	105.7	8.7	9.1	9.1	8.7	8.6	80.7	89.2	0.586	0.598
	4	14.5	104.8	1.5	4.0	21.6	103.7	4.6	4.4	4.5	4.3	4.4	65.3	94.6	0.595	0.614
	5	16.5	106.4	0.8	4.0	19.5	105.4	10.7	9.6	8.9	8.2	7.8	77.4	89.1	0.573	0.587
	6	18.3	105.6	0.9	4.0	20.6	104.9	5.9	6.8	7.0	6.9	6.9	84.0	92.7	0.584	0.595
	7	22.2	98.2	0.1	3.9	22.3	110.0	1.2	1.4	1.4	1.4	1.5	92.8	88.4	0.672	0.725
Clark	1	23.5	95.2	0.7	4.0	25.4	95.3	2.2	2.6	2.7	2.8	2.9	82.7	88.1	0.768	0.721
	2	22.4	97.2	1.2	4.0	24.8	96.0	4.3	4.5	4.6	4.6	4.7	82.5	88.7	0.736	0.756
	3	19.7	102.1	1.3	4.0	22.9	100.8	7.3	7.0	7.3	7.0	7.1	81.8	92.1	0.651	0.671
	4	18.4	100.0	1.6	4.0	23.9	98.3	5.1	5.0	5.1	5.0	5.2	72.4	90.6	0.686	0.714
Fulton	1	13.5	107.5	0.6	4.0	17.3	107.5	11.4	14.9	16.8	17.4	18.6	66.0	83.4	0.542	0.551
	2	15.2	107.4	0.8	4.0	17.6	106.8	9.8	14.4	15.5	16.4	17.7	74.4	84.0	0.544	0.557
	3	14.2	107.7	0.8	4.0	17.3	107.4	14.8	18.0	19.7	20.3	21.3	70.3	83.2	0.540	0.552
	4	18.2	103.2	0.6	6.0	19.1	103.3	3.2	3.6	5.0	5.1	5.2	79.5	81.7	0.607	0.620
Adair	1	22.1	96.9	2.2	3.8	25.8	94.8	3.7	3.8	4.0	4.1	4.2	78.1	86.9	0.783	0.821
	2	18.4	94.3	1.8	3.9	29.6	92.6	1.0	1.1	1.3	1.3	1.4	62.5	93.9	0.839	0.871
	3	30.5	89.1	0.3	3.8	31.1	88.8	1.4	1.5	1.6	1.5	1.5	90.0	91.2	0.939	0.945
	4	22.6	94.3	4.6	4.0	28.5	90.6	2.3	2.3	2.3	2.3	2.4	75.1	86.2	0.831	0.915
	5	23.9	93.8	1.5	4.0	27.5	92.5	2.5	2.6	2.6	2.6	2.5	78.8	87.6	0.841	0.869
	6	28.0	93.4	0.5	5.9	28.4	92.9	4.3	4.0	3.9	3.7	3.6	82.7	83.0	0.939	0.949
	7	21.5	97.8	2.9	5.9	27.7	93.8	3.7	3.6	3.5	3.5	3.5	69.9	82.5	0.852	0.930
	8	26.5	93.7	3.9	5.1	27.0	90.2	2.1	2.0	2.1	2.1	2.2	78.6	80.6	0.933	0.929

CBR test run according to ASTM D 1883-61T.
Specimens prepared in accordance with ASTM D 698-58T (AASHO T99-57), Method B.

TABLE 5: SUMMARY OF ASTM CBR DATA (SAMPLE HEIGHT 5 INCHES)

Location	Test Number	As Molded Moisture Content (Percent)	As Molded Dry Density (Lbs/cu.ft.)	Axial Swell (Percent)	Swell Time (Days)	After Soaking Moisture Content (Percent)	After Soaking Dry Density (Lbs/cu.ft.)	CBR (Percent) Penetration (Inches) 0.1	0.2	0.3	0.4	0.5	Degree of Saturation Before Soaking (Percent)	Degree of Saturation After Soaking (Percent)	Void Ratio Before Soaking	Void Ratio After Soaking
AASHO	1	14.7	108.7	1.8	3.8	19.2	106.8	1.0	1.1	1.2	1.3	1.4	73.1	90.7	0.538	0.566
	2	9.5	112.1	3.7	4.0	20.6	108.1	0.3	0.3	0.4	0.4	0.4	51.8	100.0	0.492	0.548
	3	18.4	106.9	0.4	3.8	19.9	106.5	1.5	1.6	1.6	1.6	1.6	87.3	92.2	0.565	0.572
	4	12.6	112.1	2.5	4.0	18.6	109.3	1.0	1.1	1.1	1.2	1.3	68.8	94.2	0.492	0.529
Fayette	1	12.7	89.4	2.5	4.2	29.9	87.2	2.0	2.0	2.1	2.2	2.2	38.8	87.0	0.873	0.920
	2	22.9	97.3	0.6	4.0	25.0	96.7	4.3	4.5	4.5	4.3	4.3	85.2	91.8	0.723	0.733
	3	16.8	95.5	1.6	4.2	25.7	94.0	7.2	6.6	6.1	5.5	5.3	59.6	88.2	0.755	0.783
	4	18.9	97.7	1.3	4.1	24.7	96.5	7.6	7.5	7.4	7.1	6.9	70.9	90.2	0.715	0.737
Clark	1	18.9	89.9	2.7	5.0	32.1	87.6	2.7	2.8	2.9	2.9	3.0	58.4	93.6	0.877	0.928
	2	22.8	92.7	1.9	5.0	30.2	90.9	3.6	3.7	3.8	3.8	3.9	75.1	95.3	0.821	0.857
	3	26.7	93.3	1.1	4.9	29.5	92.3	5.0	5.6	5.5	5.4	5.4	89.4	96.2	0.810	0.830
	4	30.9	88.7	0.4	4.8	32.2	88.4	1.7	1.9	2.0	1.9	2.0	92.7	95.9	0.903	0.911
Fulton	1	20.5	100.7	0.6	4.7	21.8	100.1	3.3	3.8	4.4	4.8	5.3	84.1	88.2	0.647	0.657
	2	13.9	101.8	0.7	4.8	21.7	101.1	8.7	9.0	9.2	9.4	9.6	58.0	90.4	0.629	0.640
	3	17.4	103.8	0.7	4.7	20.5	103.0	9.8	11.0	11.9	12.7	14.0	77.6	89.5	0.598	0.609
	4	11.4	100.3	1.4	4.8	22.4	98.9	5.2	5.6	6.1	6.5	7.0	46.5	88.1	0.654	0.676
Adair	1	14.7	92.5	4.9	4.0	31.3	88.2	1.0	1.1	1.1	0.9	1.1	47.1	90.7	0.869	0.960
	2	19.1	91.9	4.1	4.0	29.6	88.3	0.9	1.0	1.1	1.1	1.1	60.1	85.6	0.880	0.957
	3	24.4	92.4	1.3	4.0	28.3	91.2	3.3	3.2	3.1	3.1	3.1	77.8	87.5	0.868	0.893
	4	22.8	92.7	1.9	3.8	28.4	90.9	1.8	1.9	2.0	2.1	2.2	74.1	87.4	0.866	0.901

CBR Test run according to ASTM D1883-61T.

Specimens prepared in accordance with ASTM D698-58T (AASHO T99-57), Method B, except that specimens were 5 inches in height instead of 4.59 inches.

TABLE 6: MISCELLANEOUS CBR DATA

Soil Sample	Method of Compaction	Test Number	As Molded Moisture Content (Percent)	As Molded Dry Density (Lbs/cu.ft.)	Axial Swell (Percent)	Swell Time (Days)	After Soaking Moisture Content (Percent)	After Soaking Dry Density (Lbs/cu.ft.)	CBR (Percent) Penetration (Inches) 0.1	0.2	0.3	0.4	0.5	Degree of Saturation Before Soaking (Percent)	Degree of Saturation After Soaking (Percent)	Void Ratio Before Soaking	Void Ratio After Soaking
AASHO	AASHO Test Designation T180-57, Method B	1	8.5	126.3	4.9	4.0	14.6	120.4	2.5	2.6	2.7	2.8	2.9	70.5	100.0	0.324	0.387
		2	10.5	127.5	1.8	5.0	13.1	125.2	10.7	13.3	14.3	14.1	14.3	90.3	100.0	0.311	0.335
		3	12.3	123.6	0.8	5.0	13.4	123.5	11.6	15.0	16.8	17.1	17.8	96.3	100.0	0.342	0.353
		4	13.4	122.3	0.5	3.9	14.0	121.8	6.3	8.2	9.5	10.1	10.9	98.1	100.0	0.367	0.374
		5	9.7	127.8	4.3	4.8	14.0	122.5	4.5	4.8	5.3	5.4	5.8	84.4	100.0	0.308	0.365
Fayette	Static Compaction, Variable Pressure	1	19.1	105.4	0.7	4.0	20.6	104.7	6.2	5.1	4.6	4.3	4.1	86.8	92.1	0.593	0.603
		2	17.8	106.6	0.7	3.9	20.2	105.9	6.5	5.0	4.5	4.3	4.2	83.4	93.0	0.574	0.585
		3	16.7	106.3	0.7	3.9	20.5	105.6	6.0	5.2	4.8	4.5	4.4	77.4	93.4	0.580	0.590
		4	16.0	104.4	0.9	4.7	21.6	103.4	4.7	4.0	3.8	3.6	3.7	70.7	93.3	0.608	0.623
AASHO	AASHO Test Designation T180-57, Method B, Variable Compactive Energy	11	10.7	121.5	3.2	5.0	15.6	110.4	5.2	4.9	4.8	4.5	4.5	76.0	99.4	0.376	0.420
		12	11.3	113.2	2.5	4.0	18.5	117.8	1.7	1.6	1.6	1.5	1.6	63.5	99.2	0.478	0.515

APPENDIX D

SUMMARY OF CBR'S AT DIFFERENT
MOISTURE CONTENTS AND DRY DENSITIES

TABLE 7: SUMMARY OF CBR's BY DIFFERENT METHODS OF SAMPLE PREPARATION

Soil Sample	AASHO T99-57, Method B			Stanton's Method			AASHO T99-57, Method B			AASHO T99-57, Method B (Sample 5 Inches High)			AASHO T180-57, Method B		
	Ky. CBR (Percent)	Optimum Moisture Content (Percent)	Maximum Dry Density (Lbs/cu.ft.)	Ky. CBR (Percent)	Optimum Moisture Content (Percent)	Maximum Dry Density (Lbs/cu.ft.)	ASTM CBR (Percent)	Optimum Moisture Content (Percent)	Maximum Dry Density (Lbs/cu.ft.)	ASTM CBR (Percent)	Optimum Moisture Content (Percent)	Maximum Dry Density (Lbs/cu.ft.)	ASTM CBR (Percent)	Optimum Moisture Content (Percent)	Maximum Dry Density (Lbs/cu.ft.)
AASHO	5.2	14.1	117.0	4.4	10.4	129.5	5.0	15.1	116.2	0.8	11.4	112.5	8.6	10.0	128.0
Ohio	6.5	15.8	114.0	6.3	11.0	127.2	8.3	15.3	114.5						
Fayette	10.6	20.0	110.5	12.7	13.6	117.4	10.7	16.5	106.3	8.2	18.9	97.6			
Clark	7.1	20.6	99.0	5.7	11.4	116.5	7.3	19.7	102.0	5.0	26.7	93.3			
Fulton	10.0	17.0	107.6	10.0	14.0	111.5	14.8	14.2	107.6	10.0	17.4	103.6			
Adair	5.0	22.5	97.0	4.4	15.4	116.0	3.8	21.8	97.4	1.6	22.0	92.9			

APPENDIX E

SUMMARY OF COMPUTATIONS FOR SOIL SUPPORT-KENTUCKY CBR CORRELATION

SAMPLE CALCULATION

KENTUCKY CBR - SOIL SUPPORT RELATIONSHIP

The method of relating Kentucky CBR's and soil support values is described below in the form of a sample calculation. The detailed description of the calculations pertains to data shown in Table 8, Loadmeter Station 19, Traffic Year 1960. Raw traffic data was obtained from vehicle classification and loadometer data tabulated by the Kentucky Department of Highways. The method is described as follows:

1. Kentucky Equivalent Wheel Loads (EWL's) were calculated from the traffic data, Station 19, as shown in Table 9.

   A. The total number of vehicles (5334) were classified according to vehicle type (coded 4, 12, 13, 14, 20, 23, and 26) as shown in Figure 19. The number of vehicles of each type was multiplied by the number of axles for each type. (The number of axles for passenger vehicles are not included because the weight of these vehicles is relatively small and do not affect Kentucky EWL computations). As an example, the number of Type 23 vehicles totaled 178. Multiplying 178 (vehicles) by 2 (axles/vehicle) yields 356 axles.

   B. The number of axles for each vehicle type were divided into different weight classes. The percentage of axles of a given type in a particular weight class was obtained from the loadometer and classification data. In Table 9, note that 100 percent of vehicle type 12 axles occur in weight class "less than 7 kips per axle". For vehicle type 13 axles, 69 percent of the total number of axles occurred in the weight class "less than 7 kips per axle", 10.5 percent occurred in the weight class "7 to 9 kips per axle", and etc.

   C. The total number of axles for each vehicle type and weight class was multiplied by a Kentucky equivalency factor (1, 2, 4, 8, 16, 32, 64, 128, 256 or 512) to obtain the Kentucky Equivalent Wheel Loads (EWL's). As an example, for the weight class "11 to 13 kips per axle", the sum of axles for vehicle types 13, 14, 20, 23 and 26 totals 529.1. This figure is multiplied by the Kentucky equivalency factor 2 and the resulting Kentucky EWL is 1058.2.

   D. Summing the EWL's for each weight class, a total number of EWL's (12,009.8) is obtained for the total number of vehicles (5334). This figure is converted to Kentucky EWL's (2251.4) per 1000 vehicles per day.

   E. Kentucky equivalent wheel loads per 1000 vehicles for a 20-year period was determined as follows (see Table 8, Station 19):

$$20 \text{ Years} \times \frac{365 \text{ Days}}{\text{Year}} \times \frac{2251.4 \text{ EWL}}{1000 \text{ Vehicles}} = 16{,}435{,}220 \text{ EWL's per 1000 Vehicles for 20-Year Period}$$

2. AASHO equivalent axleloads were calculated from the traffic data, Station 19, as shown in Table 10.

   A. The total number of vehicles (5334) of each type (Figure 19) were divided into tandum and single axle groups.

   B. The total number of axles were divided into various weight classes. The percentage of axles of a given type in a particular weight class was obtained from the loadometer and classification data.

TABLE 8: KENTUCKY CBR - SOIL SUPPORT CORRELATION DATA

Station Number and Location	Traffic Year	Kentucky Equivalent Wheel Load (EWL) Per 1000 Vehicles Per 20-Yr. Period	Kentucky Flexible Pavement Design Curve	AASHO Daily Equivalent 18-Kip Axleload Application SN 1	SN 2	SN 3	SN 4	SN 5	SN 6		Assumed Kentucky CBR Values 3	4	6	8	10	15	20	25	30	50	70	80	90
31, US 40, 8.4 Miles West of Frenchburg	1957	6,002,790	IV	21.0	21.8	21.8	20.7	20.2	20.4	Combined Thickness	16.6	15.0	12.9	11.8	11.0	9.5	8.9	8.3	7.8				
										Structural Number	3.51	3.24	2.86	2.66	2.52	2.25	2.14	2.03	1.94				
										AASHO EAL	20.9	21.5	21.8	21.8	21.8	21.83	21.85	21.90	21.80				
										Soil Support Value	1.6	2.3	3.2	3.7	4.2	5.0	5.4	5.7	6.0				
		6,002,790	V	21.0	21.8	21.8	20.7	20.2	20.4	Combined Thickness	18.8	16.9	14.7	13.3	12.4	11.0	10.0	9.2	8.9				
										Structural Number	3.92	3.58	3.19	2.93	2.77	2.52	2.34	2.20	2.14				
										AASHO EAL	20.80	21.10	21.60	21.80	21.81	21.82	21.83	21.83	21.84				
										Soil Support Value	0.8	1.4	2.5	3.1	3.5	4.2	4.8	5.2	5.7				
	1964	9,650,440	V	32.7	34.4	35.0	33.3	32.1	32.0	Combined Thickness	18.8	16.9	14.7	13.3	12.4	11.0	10.0	9.2	8.9				
										Structural Number	3.92	3.58	3.19	2.93	2.77	2.52	2.34	2.20	2.14				
										AASHO EAL	33.40	34.00	34.70	35.00	34.90	34.00	34.60	34.70	34.50				
										Soil Support Value	1.3	2.1	3.0	3.6	4.1	4.7	5.2	5.6	5.9				
19, I65, 20 Miles South of Elizabethtown	1960	16,435,220	VI	59.0	63.4	66.7	63.5	58.6	58.8	Combined Thickness	21.0	18.8	16.4	15.0	14.0	12.5	11.4	10.7	10.0	7.8		4.6	
										Structural Number	4.32	3.88	3.49	3.24	3.06	2.79	2.59	2.47	2.34	1.94		1.37	
										AASHO EAL	61.0	63.8	65.1	66.1	66.6	66.6	65.4	65.1	64.4	62.0		60.4	
										Soil Support Value	1.3	2.3	3.1	3.6	4.1	4.8	5.1	5.7	6.0	7.3		9.4	
	1961	10,701,800	VI	49.5	54.1	58.1	55.3	52.1	50.2	Combined Thickness	21.0	18.8	16.4	15.0	14.0	12.6	11.4	10.7	10.0	7.8	5.8	4.6	3.2
										Structural Number	4.32	3.88	3.49	3.24	3.06	2.79	2.59	2.47	2.34	1.94	1.58	1.37	1.13
										AASHO EAL	53.4	55.6	56.7	57.5	57.8	57.3	56.5	56.1	55.3	53.7	52.2	51.4	50.1
										Soil Support Value	1.4	1.9	2.9	3.4	3.9	4.5	5.1	5.5	5.9	7.1	8.4	9.3	10.0
	1963	20,681,630	VII	78.8	82.5	88.5	85.5	81.8	79.6	Combined Thickness	22.6	20.5	18.0	16.4	15.3	13.5	12.5	11.7	11.0	8.6		5.1	
										Structural Number	4.61	4.23	3.78	3.48	3.29	2.97	2.79	2.65	2.52	2.09		1.46	
										AASHO EAL	83.3	84.7	86.2	87.0	87.6	88.4	85.9	86.4	84.6	83.1		80.7	
										Soil Support Value	1.2	1.9	2.8	3.4	3.9	4.6	5.1	5.5	5.9	7.1		9.4	
12, US 41, N. Hopkinsville, Christian Co.	1960	13,721,810	VI	54.3	57.4	60.5	59.1	56.6	55.2	Combined Thickness	21.0	18.8	16.4	15.0	14.0	12.5	11.4	10.7	10.0	7.8		4.6	
										Structural Number	4.32	3.88	3.49	3.24	3.06	2.79	2.59	2.47	2.34	1.94		1.37	
										AASHO EAL	57.6	59.3	59.3	60.2	60.5	59.9	59.3	59.0	58.5	57.1		55.6	
										Soil Support Value	1.3	2.1	3.0	3.6	4.1	4.6	5.2	5.5	5.9	7.1		9.3	
8, US 25, 0.75 Miles North of Georgetown	1951	13,404,990	VI	58.9	64.9	62.8	61.6	59.8	59.1	Combined Thickness	21.0	18.8	16.4	15.0	14.0	12.5	11.4	10.7	10.0	7.8		4.6	
										Structural Number	4.32	3.88	3.49	3.24	3.06	2.79	2.59	2.47	2.34	1.94		1.37	
										AASHO EAL	60.5	62.9	62.2	62.5	62.7	63.2	63.7	63.8	64.2	64.4		61.3	
										Soil Support Value	1.4	2.2	3.0	3.6	4.1	4.7	5.6	5.6	6.1	7.3		9.5	
	1952	13,953,950	VI	59.3	61.8	64.1	62.8	60.6	59.8	Combined Thickness	21.0	18.8	16.4	15.0	14.0	12.5	11.4	10.7	10.0				
										Structural Number	4.32	3.88	3.49	3.24	3.06	2.79	2.59	2.47	2.34				
										AASHO EAL	61.4	63.0	63.4	63.8	64.0	63.6	63.2	62.9	62.6				
										Soil Support Value	1.5	2.2	3.1	3.6	4.1	4.7	5.3	5.6	6.0				
	1958	15,690,620	VI	63.7	66.9	69.2	67.2	64.9	63.9	Combined Thickness	21.0	18.8	16.4	15.0	14.0	12.5	11.4	10.7	10.0				
										Structural Number	4.32	3.88	3.49	3.24	3.06	2.79	2.59	2.47	2.34				
										AASHO EAL	65.9	65.2	61.1	66.7	64.2	68.8	68.2	68.1	67.7				
										Soil Support Value	1.5	2.2	3.0	3.6	4.1	4.8	5.4	5.7	6.0				

TABLE 9: SAMPLE CALCULATION OF KENTUCKY EQUIVALENT WHEEL LOADS

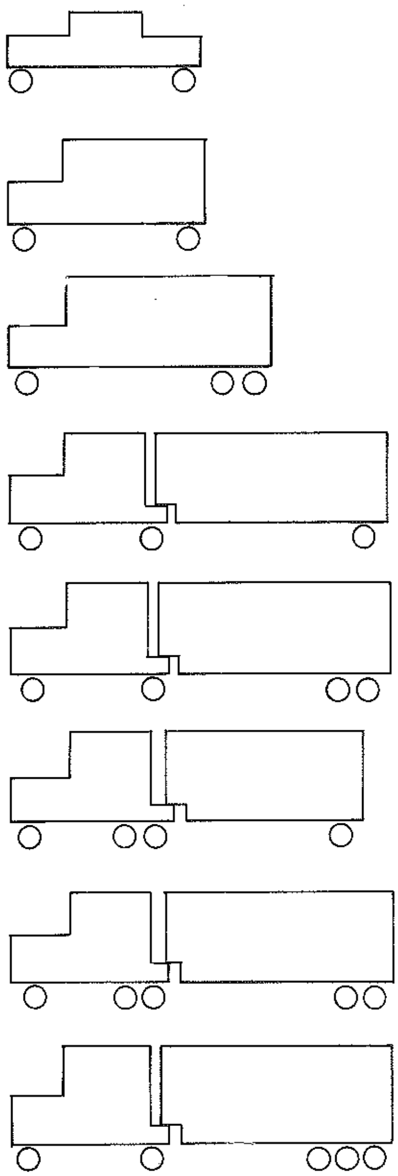
Station Number 19 Traffic Year 1960	Number of Vehicles	Vehicle-Type Code	Number of Axles Per Vehicle	Total Number of Axles
Total Number of Vehicles 5334	3945	4	-	-
	178	12	2	356
	259	13	2	518
	18	14	3	54
	179	20	3	537
	718	23	4	2872
	15	26	5	75

Kentucky Equivalency Factors	Weight Class (kips/axle)	Axles by Vehicle-Type Code						Total Axles	Equivalent Wheel Loads
		12	13	14	20	23	26		
-	Less than 7	356.0	361.0	45.0	203.0	798.4	32.5	-	-
-	7-9	-	54.4	-	107.4	519.8	25.0	-	-
1	9-11	-	34.2	-	51.6	402.1	7.5	495.4	495.4
2	11-13	-	17.1	4.5	51.6	450.9	5.0	529.1	1058.2
4	13-15	-	27.5	4.5	39.7	382.0	5.0	458.7	1834.8
8	15-17	-	10.4	-	59.6	229.8	-	299.8	2398.4
16	17-19	-	3.6	-	8.1	60.3	-	72.0	1152.0
32	19-21	-	3.6	-	3.8	23.0	-	30.4	972.8
64	21-23	-	3.6	-	-	-	-	3.6	230.4
128	23-25	-	-	-	8.1	-	-	8.1	1036.8
256	25-27	-	-	-	3.8	-	-	3.8	972.8
516	27-29	-	3.6	-	-	-	-	3.6	1857.6
	TOTALS	356.0	518.0	54.0	537.0	2872.0	75.0		12,009.2

$$\frac{12{,}009.2 \text{ EWL}}{5334 \text{ Vehicles}} = \frac{2251.4 \text{ EWL}}{1000 \text{ Vehicles}}$$

TABLE 10: SAMPLE CALCULATION OF AASHO EQUIVALENT AXLELOADS

Weight Class (kips/axle)	Number of Axles Vehicle-Type Code						Total Axles	SN=1		SN=2		SN=3		SN=4		SN=5		SN=6	
	12	13	14	20	23	26		AASHO Equivalency Factors	EAL	AASHO Equivalency Factors	EAL	AASHO Equivalency Factors	EAL	AASHO Equivalency Factors	EAL	AASHO Equivalency Factors	EAL	AASHO Equivalency Factors	EAL
SINGLE AXLES																			
<7	356.0	361.0	18.0	203.0	327.4	5.0	1270.4	.003	3.8	.004	5.1	.004	5.1	.003	3.8	.002	2.5	.002	2.5
7-9		54.4		107.4	394.9	7.5	564.2	.03	16.9	.05	28.2	.05	28.2	.04	22.6	.03	16.9	.03	16.9
9-11		34.2		51.6	218.3	2.5	306.6	.08	24.5	.10	30.7	.12	36.8	.10	30.7	.09	27.6	.08	24.5
11-13		17.1		51.6	100.5		169.2	.17	28.8	.20	33.8	.23	38.9	.21	35.5	.19	15.2	.18	30.5
13-15		27.5		39.7	109.1		176.3	.33	58.2	.36	63.5	.40	70.5	.39	68.8	.36	63.5	.34	59.9
15-17		10.4		59.6	205.3		275.3	.59	162.4	.61	167.9	.65	178.9	.65	178.9	.62	170.7	.61	167.9
17-19		3.6		8.1	56.0		67.7	1.00	67.7	1.00	67.7	1.00	67.7	1.00	67.7	1.00	67.7	1.00	67.7
19-21		3.6		3.8	24.4		31.8	1.61	51.2	1.57	49.9	1.49	47.4	1.47	46.7	1.51	48.0	1.55	49.3
21-23		3.6		-			3.6	2.48	8.9	2.38	8.6	2.18	7.8	2.09	7.5	2.18	7.8	2.30	8.3
23-25		-		8.1			8.1	3.69	29.9	3.49	28.3	3.09	25.0	2.89	23.4	3.03	24.5	3.27	26.5
25-27		-		3.8			3.8	5.33	20.3	4.99	19.0	4.31	16.4	3.92	14.9	4.09	15.5	4.48	17.0
27-29		3.6					3.6	7.49	27.0	6.98	25.1	5.90	21.2	5.21	18.8	5.39	19.4	5.98	21.5
>29		-						13.90		12.82		10.52		8.85		8.88		9.95	
SUBTOTAL	356.0	518.0	18.0	537.0	1436.0	15.0			499.6		527.8		543.9		519.3		479.5		492.5
TANDEM AXLES																			
<14			13.5		229.8	15.0	258.3	.01	2.6	.01	2.6	.01	2.6	.01	2.6	.01	2.6	.01	2.6
14-18					60.3	7.5	67.8	.04	2.7	.06	4.1	.07	4.7	.06	4.1	.05	3.4	.04	2.7
18-22					92.6	2.5	95.1	.11	10.5	.14	13.3	.16	15.2	.14	13.3	.12	11.4	.11	10.5
22-26					185.2	2.5	187.7	.23	43.2	.27	50.7	.31	58.2	.29	54.4	.26	48.8	.24	45.0
26-30			4.5		149.3	2.5	156.3	.45	70.3	.49	76.6	.55	86.0	.53	82.8	.50	78.2	.47	73.5
30-34								.81		.84		.89		.89		.86		.83	
34-38								1.38		1.38		1.38		1.38		1.36		1.38	
38-42								2.21		2.16		2.06		2.03		2.08		2.14	
42-46								3.41		3.27		2.99		2.88		3.00		3.16	
46-50								5.08		4.80		4.25		3.98		4.17		4.49	
50-54								7.33		6.87		5.93		5.39		5.63		6.17	
54-58								10.31		9.60		8.11		7.16		7.41		8.23	
>58								19.12		17.64		14.47		12.17		12.22		13.69	
SUBTOTAL			18.0		718.0	30.0			129.3		147.3		166.7		157.2		144.3		134.3
Passenger Vehicles' EAL's=Number of Auto Vehicles x .0002									0.8		0.8		0.8		0.8		0.8		0.8
Total EAL's Per 5334 Vehicles									629.7		675.9		711.4		677.3		624.6		627.6
Total EAL's Per 1000 Vehicles, Two Directional Traffic									118.1		126.7		133.4		127.0		117.1		117.7
Total EAL's Per 1000 Vehicles, One Directional Traffic									59.0		63.4		66.7		63.5		58.6		58.8



VEHICLE-TYPE CODE	VEHICLE TYPE	AXLE FACTOR
4	PASSENGER CAR	—
12	SINGLE UNIT TRUCK-2 AXLE-4 TON	2
AND	AND	
13	SINGLE UNIT TRUCK-2 AXLE-6 TON	2
14	SINGLE UNIT TRUCK-3 AXLE	3
20	TRUCK-SEMITRAILER COMBINATION 3 AXLE	3
21	TRUCK-SEMITRAILER COMBINATION (2 AXLE TRACTOR-2 AXLE TRAILER)	
= 23		4
22	TRUCK-SEMITRAILER COMBINATION (3 AXLE TRACTOR-1 AXLE TRAILER)	
24	TRUCK-SEMITRAILER COMBINATION (3 AXLE TRACTOR-2 AXLE TRAILER)	
= 26		5
25	TRUCK-SEMITRAILER COMBINATION (2 AXLE TRACTOR-3 AXLE TRAILER)	

Figure 19. Vehicle-Type Classification.

C. The number of axles for a given vehicle type and weight class were multiplied by the AASHO factors *(1)* for single and tandum axles to obtain AASHO equivalent axleloads. These factors vary with different structural numbers (SN). In Table 10 equivalency factors and EAL's for structural numbers 1 through 6 are shown. Hence, six different AASHO EAL's were obtained.

D. The EAL's for single (499.6) axles, tandem axles and cars are summed, yielding 629.7 EAL's per 5334 vehicles. This result is converted to 118.1 EAL's per 1000 vehicles. This operation is repeated for SN equal 2, 3, 4, 5 and 6.

E. Kentucky design curves are based on two directional traffic while AASHO designs are based on one directional traffic. Hence, each of the calculated AASHO EAL's of 118.1, 126.7, 133.4, 127.0, 117.7 are divided by two, yielding 59.0, 63.4, 66.7, 63.5, 58.6 and 58.8, respectively, since the traffic data was based on two directional traffic. The later values are shown in Table 8, Station 19, 1960.

3. Using the calculated Kentucky EWL's and AASHO EAL's, a relationship between Kentucky CBR and soil support was obtained.

A. Using the calculated Kentucky EWL's (16,435,220) and the proper Kentucky flexible pavement curve (VI) several pavement thicknesses for assumed Kentucky CBR's of 3, 4, 6, 8, 10, 15, 20, 25, 30, 50, and 80 were obtained. These thicknesses were 21, 18.8, 16.4, 15.0, 14.0, 12.5, 11.4, 10.0, 7.8, and 4.6 inches, respectively.

B. For each assumed Kentucky CBR, an unweighted structural number (SN) was calculated from the formula

$$SN = a_1 \, d_2 + a_2 \, d_2.$$

Values of 0.36, 0.18 and 3 inches were used for a_1, a_2 and d_1 (the minimum suggested bituminous surface thickness), respectively. For example, consider the following case (Table 8, Station 19, 1960):

Given: Assumed Kentucky CBR = 3
Combined Thickness = 21 inches
d_1 = 3 inches (suggested minimum)

SN calculation:

$$SN = (0.36)\,(3) + (0.18)\,(18) = 4.32$$

C. Using the AASHO Design Chart, Figure 20, the calculated structural number, and an interpolated AASHO EAL, a soil support value was obtained corresponding to an assumed Kentucky CBR. For instance, consider the following example:

Given: Calculated SN = 4.32
Assumed Kentucky CBR = 3
SN Values of 1, 2, 3, 4, 5, 6 corresponding to AASHO EAL's of 59.0, 63.4, 66.7, 63.5, 58.6, and 58.8 (Table 8).

Calculations:

An interpolated AASHO EAL is obtained which corresponds to an SN of 4.32. Since 4.32 lies between SN equal 4 and 5, corresponding

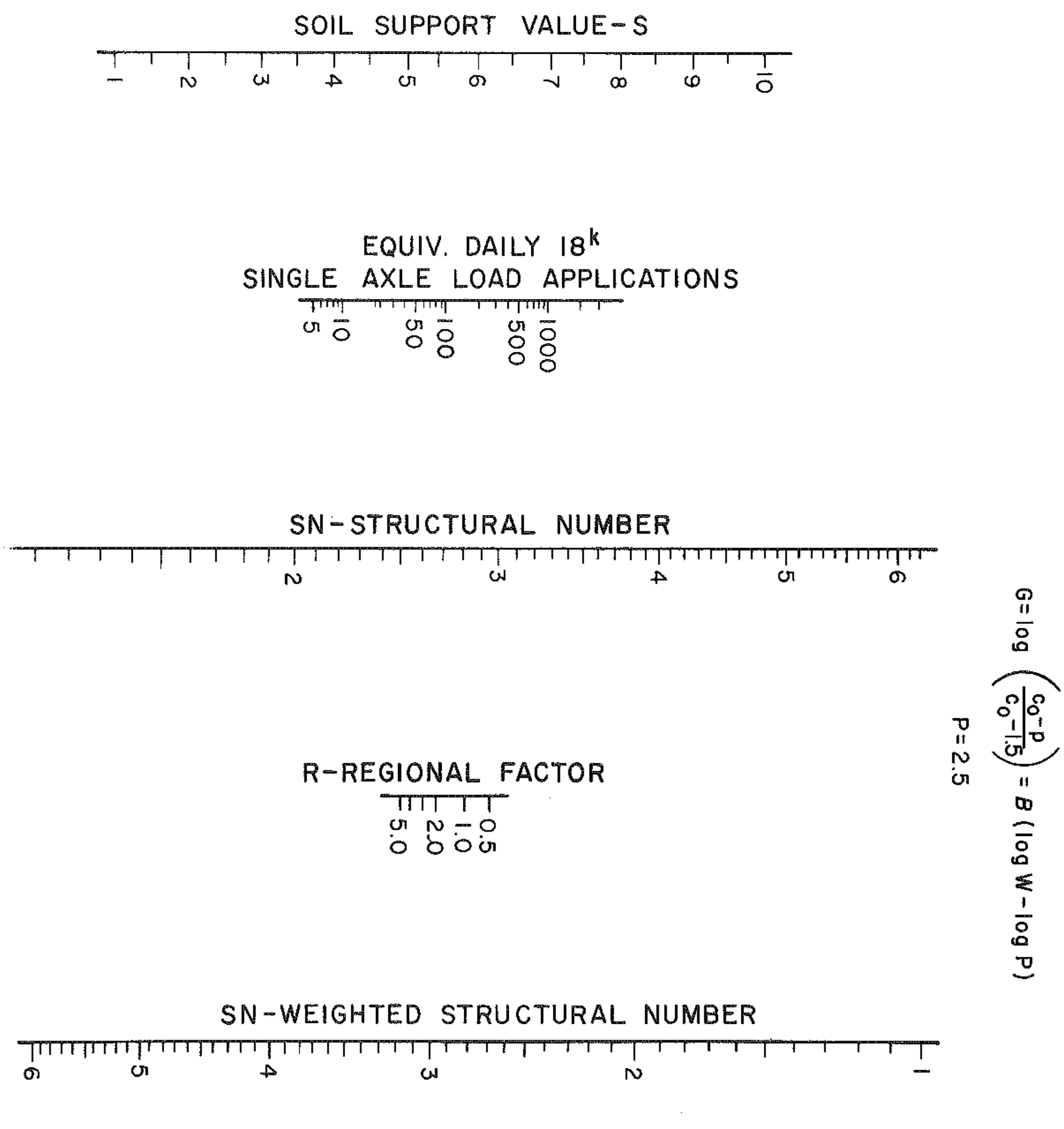
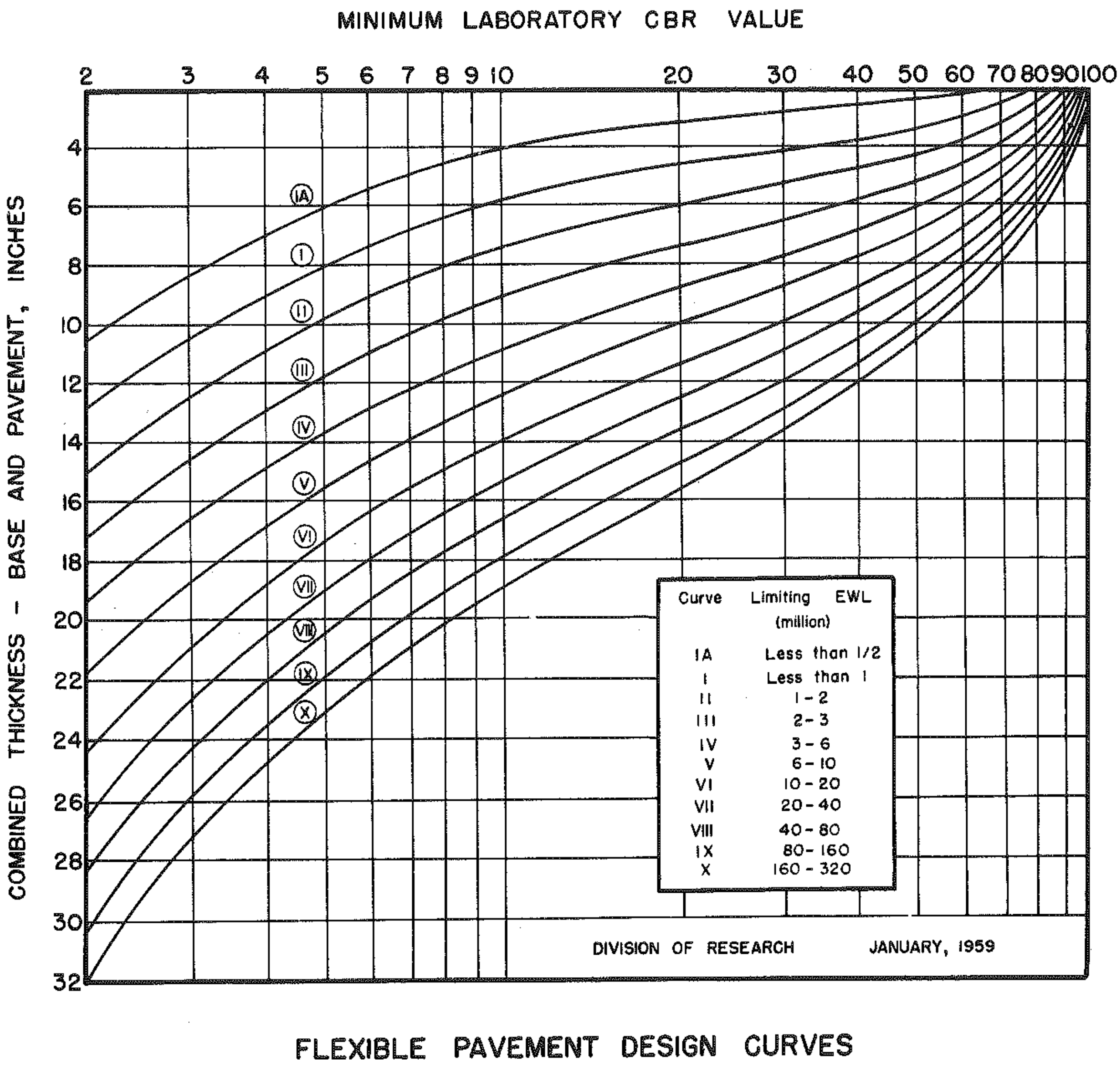


Figure 20. AASHO Flexible Pavement Design Chart (P_T = 2.5).



Revised Flexible Pavement Design Curves.

Figure 21. Kentucky Fleixble Pavement Design Curves.

to AASHO EAL's of 63.5 and 58.6, the interpolated AASHO EAL is 61.9. Entering the AASHO Design Chart, Figure 20, with this EAL and an SN of 4.32, the resulting soil support value is 1.3.

APPENDIX F

COMPARISONS OF PAVEMENT THICKNESSES FROM SOIL SUPPORT-KENTUCKY CBR NOMOGRAPHS

TABLE 11: COMPARISON OF PAVEMENT THICKNESSES

Loadometer Station Traffic Data	Assumed Kentucky CBR (Percent)	Total Pavement Thickness From Nomograph A (Inches)	Nomograph B (Inches)	Nomograph C (Inches)	Kentucky Curves(12) (Inches)
Station 31-1957	8	12.2	13.3	12.1	13.3
Ky EWL/1000 Vehicles = 822.3	15	9.3	11.0	9.1	11.0
AASHO EAL/1000 Vehicles = 40.5	50	4.9	6.6	4.6	7.0
Station 12-1966	8	14.9	16.2	14.8	15.0
Ky EWL/1000 Vehicles = 2608.1	15	11.8	13.7	11.7	12.7
AASHO EAL/1000 Vehicles = 133.5	50	6.6	8.7	6.4	7.8
Station 8-1952	8	14.5	15.9	14.3	15.0
Ky EWL/1000 Vehicles = 1911.5	15	11.4	13.1	11.2	12.7
AASHO EAL/1000 Vehicles = 121.2	50	6.4	8.4	6.1	7.8
Station 19-1960	8	14.4	15.8	14.2	15.0
Ky EWL/1000 Vehicles = 2251.4	15	11.3	13.0	11.1	12.7
AASHO EAL/1000 Vehicles = 117.1	30	6.3	8.3	6.0	7.8