RESEARCH REPORT
KTC-91-15

SENSITIVITY STUDY OF 1986 AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES

by

Herbert F. Southgate, P.E.
Chief Research Engineer

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky 40506-0043

in cooperation with

Kentucky Transportation Cabinet

and

Federal Highway Administration
US Department of Transportation

November 1991

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
KTC-91-15		

4. Title and Subtitle

SENSITIVITY STUDY OF 1986 AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES

5. Report Date
November 1991

6. Performing Organization Code

7. Author(s)
Herbert F. Southgate

8. Performing Organization Report No.6
KTC-91-15

9. Performing Organization Name and Address

KENTUCKY TRANSPORTATION CENTER
COLLEGE OF ENGINEERING
UNIVERSITY OF KENTUCKY
LEXINGTON, KY 40506-0043

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
KYHPR-88-125

12. Sponsoring Agency Name and Address
Kentucky Transportation Cabinet
State Office Building
Frankfort, KY 40622

13. Type of Report and Period Covered
Final

14. Sponsoring Agency Code

15. Supplementary Notes
Study Title: Pavement Design Parameters (for Kentucky Conditions); Prepared in cooperation with Federal Highway Administration

16. Abstract
A sensitivity study of 14 items added to the 1986 AASHTO Guide for Design of Pavement Structures indicated: (1) variations in percent reliability were most influential on the design EAL for the same pavement structure while (2) variations in standard deviations had minimal effects. (3) Resilient moduli for base and subbase materials are very dependent upon stress state (or bulk stress). (4) A method was developed to quantify the effect of drainage capabilities for various soils and its effect upon reduction in structural coefficients for base and subbase materials. (5) Literature review revealed 13 relationships to define soil stiffness. The 1986 Guide has two equations for subgrade resilient modulus that yield results differing by factors of 2 to 10. Caution in their use cannot be over emphasized. (6) A method to account for environmental changes in subgrade materials is included in the 1986 Guide. (6) Temperature effects upon asphaltic concrete stiffness are not included. Sensitivity studies showed that temperature effects on pavement stiffness and variations in Structural Number far overshadow variations in subgrade stiffness. (7) The amount of material pumped from under rigid pavements appears to be a function of the number of axles passing over the spot rather than the number of groups of axles. (8) Kentucky and AASHTO load equivalencies were compared for the same stream of truck traffic. Fatigue data from the AASHO Road Test were used to compare the Kentucky and AASHTO thickness designs for the same soil stiffness. (9) The inclusion of mechanistic principles in pavement design was evaluated and discussed. (10) A value of 3.1 is recommended for the load transfer coefficient, J, because trucks travel with their tires located at the pavement-shoulder joint. (11) Kentucky employs most of the recommended rehabilitation procedures, or has more sophisticated procedures for those not being used. In some cases, economics has ruled out one, or more, of these procedures. (12) Kentucky thickness design methods include low volume roads. (13) Life cycle costs and pavement management were not included in this study because they are subjects of individual studies currently in progress.

17. Key Words
Pavement Design, Work Concepts
Portland Cement Concrete
Thickness Designs, Serviceability
Resilient Modulus, Soil Support Value
AASHTO Guide, Load Equivalency Factors
Load Transfer Coefficient
Environment

18. Distribution Statement
Limited with approval of Kentucky Transportation Cabinet

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	150	

Form DOT 1700.7 (8-72) Reproduction of completed page authorized

EXECUTIVE SUMMARY

The objective of this research effort was to evaluate the 1986 AASHTO Guide for Design of Pavement Structures for Kentucky conditions. This research focused on flexible pavement design since a companion study relating to rigid pavements already was ongoing. The companion study has been completed and is documented by Research Report UKTRP-88-14, "Comparison of Rigid Pavement Thickness Design Systems." As the title implies, the research involved sensitivity analyses of the various factors and input parameters of the 1986 AASHTO Guide and their relation to Kentucky conditions.

The sensitivity analyses involved detailed comparisons of the 1986 AASHTO Guide with Kentucky procedures. The 1986 AASHTO Guide identified fourteen major new considerations relating to the structural design of pavements. These considerations are (1) Reliability, (2) Resilient Modulus for Soil Support, (3) Resilient Modulus of Flexible Pavement Layer coefficients, (4) drainage, (5) improved environmental considerations, (6) tied concrete shoulders and/or widened lanes, (7) subbase erosion for rigid pavements, (8) life cycle cost analyses, (9) pavement rehabilitation, (10) pavement management, (11) extension of load equivalency data, (12) improved traffic data, (13) design of pavements for low volume roads, and (14) state of the knowledge on mechanistic empirical design concepts.

Of these items, the use of tied concrete shoulders and the issue of subbase erosion for rigid pavements were addressed in greater detail in the companion report "UKTRP 88-14." The use of tied concrete shoulders already is a routine practice for all high type concrete pavement construction. The issue of subbase erosion is not directly addressed in current Kentucky designs for rigid pavements. However, the use of modified roadbeds and continued emphasis on pavement subdrainage indirectly reduces the potential detrimental effects of subbase erosion on the performance of rigid pavements. The addition of items into the AASHTO "design equation" has better enabled our pavement design staff to evaluate the potential benefits of these pavement design features.

The issues of pavement management and life cycle cost analyses are being addressed by other research efforts. Research study KYHPR 85-106 culminated in Research Report KTC 90-4, A Review and Analysis of Pavement Management Practices in Kentucky." This study summarized and documented current pavement management practices in Kentucky. Research Study KYHPR 88-118, "Life Cycle Costing of Pavement Systems" currently is ongoing.

The 1986 AASHTO Guide referenced and endorsed the continuing evolution of mechanistic design procedures for pavements. Kentucky thickness design procedures for flexible pavements are based on a mechanistic model using elastic layer concepts. Kentucky has been involved in the development and refinement of mechanistic pavement design procedures since the 1960's. A mechanistic design procedure was developed in the 1970's but was evaluated and refined for several years until the refinement of this procedure was developed in 1987 but still is being correlated with observed performance. Kentucky is unique in that we have been involved in the mechaistic design area for many years and is dedicated to continuing the development and refinement of the mechanistic design concept for pavements.

This study demonstrated the significant effects of the selected level of reliability (as defined in the 1986 AASHTO Guide) on the required pavement thickness. Variations

of overall standard deviation did not appear to have as significant effect on overall pavement thickness. Since the Kentucky procedures were developed on the basis of a mechanistic model, it is difficult to directly incorporate reliability and overall standard deviation. The sensitivity analyses from this research have confirmed that the reliability of the Kentucky procedure is variable. Information presented in the report indicates the reliability of the Kentucky procedure varies from about 80 percent for low fatigue life designs to 99 percent for higher fatigue life designs.

The most influential factors affecting pavement thickness requirements are the strength or stiffness of the subgrade soil followed by the level of Equivalent Single Axleloads (ESAL's). The study includes the results of a literature search and documents a number of relationships between the soil support scale, California Bearing Ratio, resilient modulus of the subgrade, modulus of subgrade reaction, and other means of characterizing the strength of the subgrade soil. The variations in these relationships demonstrate the complexity of comparing input parameters for pavement design procedures. It was ultimately determined that the relationship used in Kentucky to estimate resilient modulus $E_r = 1500 \times CBR$ probably is as good as any within the working range of Kentucky soils.

The 1986 AASHTO Guide contains tables and figures describing the relationship between resilient modulus and flexible layer coefficients for use in the 1986 AASHTO pavement design procedures versus Kentucky procedures. These comparisons were developed on the basis of assumed layer coefficients (0.40-0.44 for bituminous materials, 0.14 for aggregate materials) and indicate reasonable comparisons. Research Study KYHPR 86-115, "Laboratory and Field Evaluations and Correlations of Properties of Pavement Components" currently is ongoing and involves detailed testing of resilient modulus of pavement components. This study is anticipated to result in more refined data for use in both the Kentucky and AASHTO procedures.

The 1986 AASHTO Guide included a procedure for adjusting the strength of subgrade soils as a function of seasonal performance. This relationship was verified and is generally consistent with observations in Kentucky. An Analysis was conducted on the seasonal daily variations in strength of bituminous layers because of temperature and moisture fluctuations. This type of analysis is not addressed in the 1986 AASHTO Guide but is noteworthy from the perspective of future research. Generally, it was demonstrated that the temperature effects on bituminous pavements may be as influential as the effects of season on subgrade strength. Since the AASHTO procedure is empirical and based on results of the AASHTO Road Test, differentiation of these effects is difficult. The results of this analysis will benefit pavement design staff through an improved understanding of pavement performance but with no direct implementation of findings.

Kentucky has implemented pavement subdrainage for high type flexible and rigid pavements (greater than 250,000 design ESAL's per year). The benefits of pavement subdrainage in terms of extended pavement performance still are being evaluated. Research Studies KYHPR 92-142, "Evaluating the Design and Effectiveness of Subsurface Drainage Layers" and KYHPR 92-143, "Evaluation of Pavement Edgedrains and the Effect on Pavement Performance" are intended to focus on quantifying the performance benefits of pavement subdrainage. Preliminary investigations reported by others indicate that the permeable bases may extend pavement life by as much as 30 percent for flexible pavements and 50 percent for rigid pavements.

Pavement rehabilitation involves a number of activities. The 1986 AASHTO Guide identifies many factors related to the rehabilitation of pavements. It was generally concluded that Kentucky procedures addressed the parameters listed in the AASHTO Guide in some capacity. However, the specifics of pavement rehabilitation strategies must vary according to conditions within a given state.

Equivalent 18,000-pound single axleloads are a means of standardizing the distribution of axleloads within a traffic stream into a single quantity which describes the loads anticipated to be applied to that pavement. Load equivalency factors are the mechanism used to convert the relative damage to the pavement for any given loading to some quantity of damage associated with a standard 18,000-pound single axleload. Load equivalency factors used in Kentucky were developed on the basis of mechanistic procedures and vary somewhat with AASHTO load equivalencies. The 1986 AASHTO Guide does include modifications to compute load equivalency factors for tridem axle loadings. Kentucky load equivalency factors already included multiple axle groupings. This study included analyses which demonstrate that the Kentucky mechanistic design criterion incorporates the majority of experience observed at the AASHTO Road Test. However, these analyses do not completely define relationships between Kentucky load equivalency factors and AASHTO load equivalency factors. Research Study KYHPR 92-141, "Forecasting and Backcasting Equivalent Axleloads for Pavement Design and Performance" has been initiated to further define relationships between AASHTO and Kentucky load equivalency factors and the effort on pavement design requirements.

The 1986 AASHTO Guide included a section relating to pavement design for low volume roads. The Kentucky procedure is applicable for design of pavements for as low as 7,300 ESAL's. This is approximately one ESAL per day for a 20-year period. The 1986 AASHTO Guide refers to low volume roads as those with ESAL's of 700,000 to 1,000,000 over the design life. Therefore, Kentucky pavement design procedures do not require specific adaptations for use on low volume roads. The AASHTO procedure for thickness design of aggregate surfaced roads may have some limited applications in Kentucky. The procedures presented in the 1986 AASHTO Guide do provide an alternative means of verifying design requirements for low volume roads and also provide a means for designing for reduced levels of serviceability and reliability. These concepts already have been implemented by the pavement design staff for design of detour pavements, shoulder pavements used to carry construction traffic, and other pavements where a reduced level of service or reliability may be accommodated.

Appendices for this report include the results of many comparisons of pavement designs for Kentucky procedures versus 1986 AASHTO procedures for a wide range of design conditions. These comparisons will be useful for pavement design staff in evaluating and quantifying the relative pavement strategies for individual projects.

In conclusion, the report illustrates the sensitivity of the various pavement design parameters. Implementation of the findings and results of this study will be on an indirect bases as discussed.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

This study was initiated to determine the sensitivity of the 14 new considerations included in the 1986 AASHTO Guide for Design of Pavement Structures (1). These considerations are:

(1) Reliability
(2) Resilient Modulus for Soil Support
(3) Resilient Modulus for Flexible Pavement Layer Coefficients
(4) Drainage
(5) Improved Environmental Considerations
(6) Subbase Erosion for Rigid Pavements
(7) Life-Cycle Cost Considerations
(8) Pavement Management
(9) Extension of Load Equivalency Values
(10) Improved Traffic Data
(11) Design of Pavements for Low Volume Roads
(12) State of the Knowledge on Mechanistic-Empirical Design Concepts
(13) Tied Concrete Shoulders or Widened Lanes, and
(14) Rehabilitation.

This report includes information relative to the flexible pavement portion of the 1986 AASHTO Design Guide (1) and includes the effects of a few input items used in rigid pavement design. The sensitivity of the variables for rigid pavement design will be included in another report.

RELIABILITY AND STANDARD DEVIATION

Figure 1 illustrates the relationship between standard normal deviate, Zr, and percent reliability, R. Figure 2 illustrates the relationship between 18-kip EAL, structural number, SN, and percent reliability, R. The equation that was developed from the AASHO Road Test (2,3) data analysis represented a 50 percent reliability. As an example, a design EAL of 10 million corresponds to SN's of 4.79 and 5.67 at 50 and 90 percent reliability, respectively. Assuming 0.44 for a_1, another 2 inches of asphaltic concrete would be required to increase the design from a 50 percent reliability to a 90 percent reliability level. The choice of value for reliability is very influential.

Figure 3 illustrates the relationship between percent reliability, standard deviation, and percent of design EAL at a 50 percent reliability. Figure 3 illustrates that standard deviation has a very minor influence on the design level compared to the effect of percent reliability.

The sensitivity analyses from the study confirm that the reliability of the Kentucky procedure is variable. Reliability ranges from 80 percent for low fatigue life designs to 99 percent for higher fatigue designs.

RESILIENT MODULUS FOR SOIL SUPPORT

Figure 4 provides the relationship between Kentucky CBR, elastic modulus (1,500 x CBR), and resilient modulus. Figure 5 illustrates the relationship between Soil Support Value (scale 1), 1982 Kentucky CBR (scale 10), AASHTO subgrade resilient modulus (scales 11 and 13), corresponding k-values (scales 12 and 14 respectively), R-value scales (scales 5 and 6), and the original Corps of Engineers CBR (scale 15). All scales were obtained from published documents (1, 3-6). One should be careful in interpreting resilient modulus because the term quite often is interchanged with elastic modulus and the two are not the same by definition. The designer should be careful to choose the appropriate relationship to obtain the correct resilient modulus and associated "k-value" for use in rigid pavement thickness designs. For the working range of Kentucky soils, the relationship to estimate resilient modulus of E_r = 1,500 x CBR is appropriate and as good as any other relationship.

Scale 9 in Figure 5 is labeled "INCORRECT KENTUCKY CBR". This scale appears in the 1986 AASHTO Guide (1), as Scale C in Figure FF.6. The footnote to Figure FF.6 lists the source as the report by Drake and Havens (4). The referenced document (4) was checked and no such relationship could be found. The authors (4) were contacted and neither knew the source of that scale (Scale 9 in Figure 5 of this report). This scale is incorrect and invalid.

RESILIENT MODULUS FOR FLEXIBLE PAVEMENT LAYER COEFFICIENTS

Asphaltic Concrete

Figure 6 provides the relationship between elastic (resilient) modulus and the structural layer coefficient, a_1. Data values were interpolated from the original figure in the 1986 AASHTO Design Guide (1) and the following equation was obtained.

$$\text{Log}(a_1) = a + b*\text{Log}(E) + c*(\text{Log}(E))^2 \quad (1)$$

where a_1 = structural coefficient for asphaltic concrete,
a = -9.9038197211,
b = 2.958061252, and
c = -0.2244867989.

The regression statistics are:
Standard Error = 0.00256828
R^2 = 0.9996764, and
F Ratio = 9267.414.

Base Material

Figure 7 is the representation of the AASHTO equation relating elastic (resilient) modulus to the structural coefficient, a_2, for base material. The Guide recommends obtaining the modulus from a triaxial test of the base material. From that test, the sum of the principal stresses can be obtained which is defined as the stress state, θ (theta). Figure 8 illustrates the relationship between stress state, and K_1 when K_2 is assigned a value of 0.6. Note that K_1 depends upon the degree of wetness of the material and the verbal description is provided in tables in the Guide. Figure 9 provides the mechanism for selecting the appropriate K_1 for both base and subbase materials.

Subbase Material

Figure 9 is used to select the appropriate K_1 for both base and subbase materials. Figures 10 and 11 provide the appropriate relationships for subbase materials. The relationships will be discussed in more detail under mechanistic design concepts.

DRAINAGE

Section 2.4.1 of the 1986 AASHTO Design Guide provides the relationship between the verbal description of quality of drainage and the time required for water to be removed. Table 2.4 (1) provides additional data as a function of the percent of time that the material is exposed to near saturation for flexible pavements. Table 2.5 (1) provides similar information for rigid pavements. These relationships have been combined in Figures 12 and 13 for flexible and rigid pavements, respectively. The output is m_i from Figure 12 and c_d from Figure 13.

M_i modifies the effective thickness of the base and subbase layers. Figure 14 illustrates the effect of m_2 upon the structural number, SN, for a three-layered pavement structure for which 1/3 of the total thickness is asphaltic concrete and 2/3 is a crushed stone base course. For example, when m_2 is 1.0, the SN is 7.2 for a 30-inch design thickness. A variation of +/- 0.4 for m_2 modifies the SN to 8.3 and 6.1 respectively for the same 30-inch design--a change of +/- 1.1, which at 0.44 for the coefficient a_1 equals 2.5 inches of asphaltic concrete. Figure 15 gives the 1981 Kentucky 33 percent thickness design curves in inches and Figure 16 shows them converted to SN assuming 0.44 and 0.14 for coefficients a_1 and a_2, respectively, in the equation

$$SN = a_1 d_1 + a_2 d_2 m_2 \qquad 2$$

where
d_1 = thickness of asphaltic concrete, in.,
d_2 = crushed stone base thickness, in., and
m_2 = a modifying factor to account for the degree of wetness.

Assuming m_2 has a value of 0.7 instead of 1.0, Figure 17 shows that the same pavement thickness designed for 6 million EAL would be adequate for approximately 2.1 million EAL--approximately 1/3 the anticipated fatigue life. These analyses provide strong arguments for constructing drainage systems to remove water from the pavement structure.

The sensitivity analyses above describes the benefits of improved subgrade drainage but are not directly related to Kentucky design procedures. While Kentucky uses pavement subdrainage for all high type pavement designs, it was not intended or expected that use of improved pavement subdrainage procedures would result in cost savings by reduced pavement thicknesses. Instead, it was anticipated that use of pavement subdrainage would extend the service life of Kentucky pavements by rapidly removing moisture from the upper regions of the pavement structure. In bituminous pavements, subsurface drainage was anticipated to reduce the potential for moisture damage to the bituminous layers and to reduce the degree of saturation for aggregate bases and the associated potential for isolated base failures and other moisture related loss of support. Subsurface drainage for rigid pavements was anticipated to reduce the potential for pumping of fines from base layers and for moisture related damage to the concrete pavement. In summary, Kentucky's current approach to pavement subsurface drainage is rapid removal of water penetrating the pavement from the surface.

IMPROVED ENVIRONMENTAL CONSIDERATIONS

The 1986 AASHTO Design Guide (1) suggests a method for obtaining a weighted average resilient modulus for the subgrade to account for changes in stiffness due to changes in moisture content. The 1959 Kentucky thickness design curves (4) were based upon the Kentucky CBR method which requires a soil sample to be soaked until swelling ceases. ASTM requires a soaking period of 72 hours. The main purpose of the extended soaking time is to recognize that Kentucky clays take longer to absorb water and for the water to be removed. Thus, the ASTM test method would not provide sufficient time for the sample to be saturated and should result in a higher CBR than that resulting from the Kentucky test procedure.

Since the late 1970's, Kentucky investigators have been able to confirm seasonal changes resulting from Road Rater tests. The 1959 Kentucky thickness design curves were based upon Kentucky CBR tests on subgrade samples obtained from successful and failed pavements. Kentucky thickness design curves modified in 1968 were based upon the Kentucky CBR test results. Assuming a design SN = 5.0, serviceability level of 3.0, CBR = 6.0 (resilient modulus of 3,283 psi), and 50 percent reliability, the 18-kip design EAL is 2,930,000. Figure 18 illustrates the change in design EAL as a function of relative change in subgrade stiffness during the year. The effective SN is reduced to 4.688, the design CBR to 5.28, and design EAL to 2,292,835 -- 78 percent of the original design EAL.

The 1986 AASHTO Design Guide does not consider the change in stiffness of the asphaltic concrete due to the annual change in pavement temperature. Figure 19 shows the change in elastic modulus as a function of average pavement temperature. Figure 20 (7) provides the means to estimate the temperature at depths within the asphaltic concrete for 1300 hours standard time. The input value is a combination of the pavement surface temperature and the 5-day average air temperature history. Figure 21 illustrates the annual temperature variation assuming a 100 °F annual change in temperature (typical Kentucky condition) for a pavement structure consisting of 6 inches asphaltic concrete on 12 inches of a crushed stone base. The subsequent variation in pavement stiffness using Figure 19 results in the variation in the structural coefficient, a_1, through the use of Figure 6. Environmental changes affect different portions of the pavement structure in different ways during the year. Figure 22 illustrates the changes in relative stiffness of the subgrade and its effect on the structural coefficients, a_2, and the effect of pavement temperature on the stiffness of the asphaltic concrete through the coefficient, a_1. Figure 23 shows the total variation in SN as a function of annual variations in coefficients a_1 and a_2. This illustrates that the annual change in stiffness of the asphaltic concrete due to pavement temperature is considerably more influential on SN than the effect of annual change in subgrade stiffness. A method to include adjustments for such effects should be considered for inclusion in the next revision of the AASHTO Design Guide.

SUBBASE EROSION FOR RIGID PAVEMENTS

Table 54 (2) provides the pumping index data at a serviceability level of 1.5, or W = 1,114,000 load applications. Comparing the volume of material pumped from under both lanes of the same pavement section provides a direct comparison of single versus tandem axle groups. The pluses in Figure 24 represent those sections that had reached a terminal serviceability of 1.5 and were considered to have failed. The dots represent pavements that had received 1,114,000 load applications but had not reached a serviceability level of 1.5. For those pavements that survived (dots), the 2:1 trend line fits the data very well. This suggests that the volume of material pumped from under the pavement was simply a function of the number of axle impacts and not entirely due to fatigue. Another trend in the data was that those pavements that failed were either thin and/or were located on Loops 5 and 6 (heaviest loadings).

Subbase erosion under rigid pavements is not directly addressed in current Kentucky designs for rigid pavements. However, the use of modified roadbeds and continued emphasis on pavement subdrainage indirectly reduces the potential detrimental effects of subbase erosion on the performance of rigid pavements.

LIFE-CYCLE COST CONSIDERATIONS

This item is the subject of an ongoing study KYHPR-88-118, "Life Cycle Costing of Pavement Systems and was eliminated as a part of this study.

PAVEMENT MANAGEMENT

Pavement management has been the subject of study KYHPR-85-106 which culminated in Research Report KTC 90-4, "A Review and Analysis of Pavement Management Practices in Kentucky." Thus, pavement management was not investigated as a part of this study.

EXTENSION OF LOAD EQUIVALENCY VALUES

The extended sets of load equivalencies included in Appendix D of the 1986 AASHTO Design Guide may be duplicated by substituting 3.0 for the terminal level of serviceability and/ or a value of 3 for L_x for tridem axle groups. It is to be noted that no relationships are presented for a two-tired axle that represents a steering axle. At the AASHO Road Test, the steering axleloads were sufficiently low for all vehicles so that the effects of these axles were included by default as a part of the loaded axles of the tractor and trailer. Today's trucks apply sufficiently heavy steering axleloads to require a specific load equivalency relationship for a two-tired axle. The use of the four-tired equation for the two-tired axle yields a load equivalency of approximately one-half the appropriate value. However, the proof of all such relationships involves matching the design fatigue with fatigue accumulated during the actual time the pavement was subjected to traffic.

Designers use the term 20-year life as a way of expressing a fatigue design. Pavements usually fail by fatigue which is dependent upon loading history and not number of years. If truck traffic volume increases at a greater rate than originally estimated, the fatigue life is consumed at a greater rate. As load limits are increased, fatigue accumulates even more because the load equivalency increases approximately as the fourth power of the load increment. The Kentucky thickness design curves matched

Kentucky empirical data and the AASHTO design method supposedly matches results from the AASHO Road Test. Two different analyses were performed during this study to determine how well these two design methods agree.

Soil samples obtained from the AASHO Road Test were submitted to each of nine testing laboratories as a part of a round robin testing program and the Division of Research (a parent organization of KTC) was one of these laboratories. The average Kentucky CBR test value was 5.2.

Appendix A of reference (2) contains the number of load applications for each pavement section for five specific levels of serviceability. For a given level of serviceability, the repetitions were multiplied by the AASHTO load equivalency for the actual loads employed on that section yielding the 18-kip EAL for that pavement. The layer thicknesses were converted to Structural Number, SN, using assumed values for coefficients a_1, a_2, and a_3 of 0.44, 0.14, and 0.11, respectively. The EAL was plotted for each SN to produce Figures 25-29 for serviceability levels of 3.5, 3.0, 2.5, 2.0, and 1.5, respectively. Superimposed on each of Figures 25-29 is the Kentucky thickness design curve converted to SN corresponding to CBR 5.2 and the solution of the AASHTO equation for that level of serviceability. According to the level of serviceability, the Kentucky design curve incorporates approximately 90 to 95 percent of the AASHO Road Test data in a particular range but does not fit other areas as well. This is because the Kentucky curves were developed in such a way that as the design EAL increased, so did the level of serviceability. Figure 25 shows that the Kentucky thickness design curve does not incorporate as many data points as Figures 26-29. This difference is not thought to be significant because the visible deterioration at a serviceability of 3.5 would not be sufficient to initiate any major rehabilitation. The following table shows the EAL ranges and corresponding levels of serviceability for which the Kentucky design curve for CBR 5.2 best matches the AASHO data.

	RANGE OF EAL	
LEVEL OF SERVICEABILITY	FROM	TO
1.5	0	30,000
2.0	30,000	80,000
2.5	80,000	800,000
3.0	800,000	AND UP.

Figure 30 is a compilation of the calculated EAL-SN relationships used in the AASHTO equation for each of the levels of serviceability. Figure 31 is a compilation of calculated EAL-SN data from each of the ranges listed, the Kentucky design curve, and the appropriate portions of the AASHTO equation. AASHO Road Test data confirm that increasing the level of serviceability as a function of increased design EAL supports the Kentucky design methodology. Results would have been very similar to that obtained by the AASHTO method had the Kentucky procedure been developed based on fixed levels of serviceability. The second analysis involved comparing the two sets of load equivalency relationships. The Kentucky load equivalencies are based upon the concept of work at the bottom of the asphaltic concrete layer. They were derived by using the Chevron n-Layer computer program to analyze 80 pavement structures comprised of all possible combinations of layer thicknesses at the AASHO Road Test for those pavements having 3, or more, inches of asphaltic concrete. Specific axle/tire arrangements were:

1. 2-tired steering axle,
2. 4-tired single axle,
3. 4-tired tandem axle group,
4. 8-tired tandem axle group,
5. 6-tired tridem axle group,
6. 12-tired tridem axle group,
7. 16-tired four-axle group,
8. 20-tired five-axle group, and
9. 24-tired six-axle group.

Multiplicative factors have been developed to account for increased tire contact pressures that have been measured in the past three years (8). These relationships are based on theory. As a part of this study, load equivalency factors were developed for:

10. 6-tired tandem axle group, and
11. 10-tired tridem group.

Table 1A provides the format of the equation and the values for all equations for the 11 combinations of tire/axle groups. Table 1B provides the adjustment factors that have been developed to account for imbalanced loads between the two axles of a tandem and another set for imbalanced loads between the three axles of a tridem (8). The combined effect of the total group load and imbalanced load distribution between the axles within the group is the product of the load equivalency factor from Table 1A and adjustment factor from Table 1B.

The AASHTO load equivalencies were developed from empirical data obtained from the Road Test. Figure 32 illustrates the comparison of load equivalency relationships for the steering axle and the 4-tired single axle at AASHTO serviceability levels of 2.0, 2.5, and 3.0. Figure 33 compares the 8-tired tandem axle group and 12-tired tridem axle group in a similar manner. It should be noted that tridem axle groups were not used on any trucks at the AASHO Road Test. For the 4-tired single axle, the Kentucky relationship agrees quite closely in the range of 12-kip to 30-kip axleloads employed at the AASHO Road Test.

Figure 33 indicates more difference between Kentucky and AASHTO load equivalencies when the gross load on the assembly is assumed to be evenly distributed to all axles in that assembly. Analyses (8) of recorded tandem axleloads and tridem axleloads (8) indicated that approximately 10 to 12 percent of these assemblies do distribute the load evenly among the axles. Eighty eight to 90 percent do not distribute the load equally. Certain suspensions prohibit the loads from being equally distributed, particularly if the pavement profile is uneven. When uneven load distributions are taken into account, the Kentucky and AASHTO relationships agree quite well over the range of tandem axleloads (24-48 kips) used at the AASHO Road Test.

Kentucky thickness design curves for rigid pavements are based upon the same design EAL used for flexible pavements. The reasoning was that only one set of load equivalencies would be calculated. The design thicknesses in other procedures should be adjusted to reflect the adjusted design EAL. A hypothetical design EAL of 8 million for flexible pavements corresponded to approximately 14 million EAL in the AASHTO rigid pavement design method. The rigid pavement thickness assigned to 14 million EAL in the AASHTO method was assigned to a Kentucky design EAL of 8 million--both represent identical traffic conditions.

Of the first 3,000 trucks passing over a Weigh-In-Motion scale at one Interstate site during 1989, data for 28 trucks were discarded for obviously incorrect data (such as 0.3 feet between axles) and the remaining 2,972 were analyzed. Each truck was classified according to the FHWA Vehicle Classification scheme used as a part of the new FHWA Traffic Monitoring Guide. The recorded axleloads were used to calculate the AASHTO load equivalency for that axleload according to the appropriate one of three sets of relationships furnished in the 1986 AASHTO Design Guide for both flexible and rigid pavements. In addition, Kentucky load equivalencies were calculated for the same single axleload, for the gross load assuming equally loaded axles within tandem and tridem axle groups as appropriate, and using the individual recorded axleloads for the same group to obtain the multiplicative factor to account for uneven loading on those same axles. The calculated load equivalency for each axle group was recorded. After all 2,972 trucks had been analyzed, the load equivalencies were sorted according to axle location on each style of truck and then summed according to the respective axle assembly description--steering, drive single, trailer single, drive tandem, trailer tandem, and trailer tridem (there were not any drive tridems in this group of trucks). The summations are presented in Table 2.

Some observations are:

1. The total load equivalencies for steering and single axles are nearly identical.
2. Load equivalencies for rigid pavements for both tandems and tridems are nearly twice that for flexible pavements. Additional analyses will be necessary to explain the discrepancy.
3. Assuming equally loaded axles within the axle assembly, the AASHTO method results in the total load equivalencies that are approximately 23 percent higher than calculated using the Kentucky system.
4. Accounting for the actual recorded axleloads, the AASHTO total is 88.5 percent of the Kentucky total.
5. Accounting for increased tire contact pressure of 105 psi as observed during the past three years combined with accounting for uneven load distributions and assuming 7.5 inches of asphaltic concrete, the total AASHTO load equivalency for flexible pavements is only 65 percent of the Kentucky total load equivalencies.
6. Kentucky load equivalency relationships very nearly account for the designed fatigue life being consumed during the actual number of years the pavement was in service regardless of its location.

The above analyses do not completely define relationships between Kentucky load equivalency factors and AASHTO load equivalency factors. Research Study KYHPR-92-141, "Forecasting and Backcasting Axleloads for Pavement Design and Performance" has been initiated to further define relationships between AASHTO and Kentucky load equivalency factors and the effect on pavement design requirements.

IMPROVED TRAFFIC DATA

Kentucky is implementing requirements contained in the FHWA Traffic Monitoring Guide. Prior to that, the Planning Division of the Kentucky Transportation Cabinet collected detailed traffic data for a number of years consisting of total vehicle volumes, manual vehicle classification counts, and loadometer studies. Data resulting from the new data collection efforts coupled with historical traffic data have been incorporated into a system to predict estimated EALs used in making pavement designs (9). These data have been used by Kentucky Transportation Center investigators in some instances in forensic studies of pavement failures. In one case, data analyses indicated the pavement should have failed one year sooner than it did. The new data collection procedures will improve upon the excellent data collection scheme already in place.

DESIGN OF PAVEMENTS FOR LOW VOLUME ROADS

The 1986 AASHTO Guide included a section on pavement design for low volume roads. The Kentucky procedure is applicable for design of pavements for as low as 7,300 ESAL's. This is approximately one ESAL per day for a 20-year period. The 1986 Guide refers to low volume roads as those with ESAL's of 700,000 to 1,000,000 over the design life. Therefore, Kentucky pavement design procedures do not require specific adaptations for use on low volume roads. The AASHTO procedure for thickness design of aggregate surfaced roads may have some limited applications in Kentucky. The procedures presented in the 1986 AASHTO Guide do provide an alternative means of verifying design requirements for low volume roads and also provide a means for designing for reduced levels of serviceability and reliability. These concepts already have been implemented by the pavement design staff for design of detour pavements, shoulder pavements used to carry construction traffic, and other pavements where a reduced level of service or reliability may be accommodated.

STATE OF THE KNOWLEDGE ON MECHANISTIC-EMPIRICAL DESIGN CONCEPTS

Kentucky's 1981 pavement thickness design method is listed as reference 10 in Part IV (1) and recognized as one of three "mechanistic-design procedures."

The 1948 and 1959 sets of pavement thickness design curves were based upon empirical observations and testing programs on pavements in Kentucky. The 1968 set of curves tied theoretical analyses based upon elastic theory and the use of the Chevron n-Layer computer program (10) to what was thought to be observed behavior. Analyses indicated that the empirical basis was not equal to pavement surface deflection as had been suspected, but was equal vertical compressive strain at the top of the subgrade for high volume roads and tensile strain at the bottom of the asphaltic concrete for farm-to-market roads. The concept was that Kentucky's farm-to-market roads usually had such poor geometrics in terms of grades and curves that high speeds resulting in hydroplaning simply would not occur in most cases. The criterion was to let the subgrade rut but ensure that the asphaltic concrete remained as an entity. Conversely, for high volume roads such as Parkways and Interstates, the subgrade should not be allowed to rut in order to assure that hydroplaning would not occur because the subgrade moved out from under the wheel paths. This did not provide assurance that rutting would not take place within the asphaltic concrete due to consolidation or shear flow. Potential consolidation is a function of construction control. Prevention of shear flow is a function of materials, mix design, and construction. Between the two extremes, a proportioning method was employed as a means of gradually transferring from one controlling criterion to the other.

A major advancement in pavement design was achieved with publication of the 1987 Kentucky thickness design curves (11). Some fine tuning is still needed and will depend upon collection of field data using both the Road Rater and a falling weight deflectometer. The advancement was application of the principals of work as defined by classical physics. It has the advantage of being able to easily convert laboratory test data to equivalent values based upon work, strain energy density, work strain, or work stress. Previous experience is incorporated into the method based upon work. The same thickness designs are obtained regardless of whether the tests are performed under strain control or stress control. Previous efforts to resolve results from these two test procedures failed (12).

One advantage of basing pavement designs upon work is that the effects of shear are included whereas shear is not included in criteria based upon individual components of stress or strain. Pavement design methods incorporating some measure of mechanistic design are based upon the tensile strain at the bottom of the asphaltic concrete and/or vertical compressive strain at the top of the subgrade. This concept was the basis of the 1968, 1971, 1977, and 1981 Kentucky thickness design curves. There is one serious flaw in the procedures. At the bottom of the asphaltic concrete, the tensile strain has the highest numerical values but the radial strain at the same point may have a numerical value that is nearly 80 percent of the tensile strain, yet is not included.

If calculations are specified to be made at locations under the center of one load, shear has a value of zero. When superposition principals are used, additional loads may be employed to better approximate pavement behavior and shear will not be zero under the center of one of the loads due to the influence of nearby loads. Kentucky research (13) clearly indicates that the most sensitive position within the asphaltic concrete layer is the position under the edge of a dual tire closest to the adjacent tire. Shear at that location reaches its maximum value and helps to explain the shear flow seen in pavements that have been trenched across the lane. Work strain includes the effect of **all** components of strain and is of the same order of magnitude as any one component. Work strain is not a pure strain because the effects of Poisson's ratio cannot be canceled prior to taking the square root, but the effect of Poisson's ratio is minor.

During the development of the 1968 Kentucky thickness design curves, a modulus of 25,000 psi was assigned to the dense graded aggregate (DGA) layer. The effects of using a constant modulus for DGA without regard to the influence of the subgrade were not noticeable until the modulus of the subgrade equalled and/or exceeded 25,000 psi. At that point, unusual behaviors were observed. The stiffness of an unbound material is based upon the stiffness of the layers above and below. For example, a crushed limestone may mobilize stiffnesses approaching the crushing force when confined between two thick steel plates. However, if the same crushed limestone material were placed on a thick soft rubber mat as was done in tests at Ohio State University, the potential stiffness of the limestone cannot begin to be reached. This reaction caused the Division of Research of the Kentucky Department of Highways to modify the 1968 Kentucky thickness curves in 1971. At that time, an extensive effort (12) was expended to resolve the concept of thickness designs based upon either strain controlled tests or stress ~~controlled tests. Efforts were not successful.~~

The principles of work were first applied during development of the rigid pavement thickness design curves. After completion of that effort in 1984 (14), principles of work were applied during development of flexible pavement design procedures. Only then were problems overcome for making data from stress, or strain, controlled tests compatible for use in pavement thickness designs.

The same problem of using one value for stiffness of the base material has arisen in the 1986 AASHTO Design Guide (1). Data from these analyses are contained in Tables FF.1 and FF.2 (1). Those results were used in the development of values of stress state (sometimes referred to as bulk stress) used to obtain the appropriate value for K_1 as shown in Figures 7-11 in this report. The state of stress is defined as the sum of the three principal stresses. The test specimen is placed between two rigid heads. The test does not show the effects of the change in stresses when the material is placed on a softer medium. To confirm results, the Chevron n-Layer computer program was used to study the effects of a matrix of stiffnesses for the crushed stone layer and another matrix of stiffnesses for the subgrade layer for a constant pavement thickness of 6 inches of asphaltic concrete on 10 inches of crushed stone base material. Stiffnesses ranged from 4,500 to 45,000 psi for the crushed stone and 4,500 to 15,000 psi for the subgrade. There were stiffnesses of the crushed stone layer that were not as high as the subgrade. The stress state of the unbound crushed stone layer must remain in a compression mode or the material will fall apart. Figure 34 shows that seven combinations of stiffnesses theoretically resulted in a net tension mode at the center of the stone layer. These coincided with a high ratio of stone to subgrade moduli. Figure 34 could hardly be used as a criterion for bulk stress or bulk strain. The same may be said about Figure 35 that displays the relationship between strain energy density and bulk stress. Figure 36 indicates that the maximum modular ratio cannot exceed 4.5 or the stress state (or bulk state) will be in a tension mode. Figure 37 compares work stress to bulk stress and this relationship might be developed into a meaningful criterion. Figure 38 best shows the effect of a layer having less stiffness than the layers above and below. Note how the iso-subgrade-moduli lines cross each other.

TIED CONCRETE SHOULDERS OR WIDENED LANES

For plain jointed and jointed reinforced portland cement concrete pavements, the recommended range of 2.5 to 3.1 is given in Table 2.6 (for the load transfer coefficient. "For jointed concrete pavements with dowels and tied shoulders, the value of J should be between 2.5 and 3.1 based on the agency's experience. The lower J-value for tied shoulders assumes traffic is not permitted to run on the shoulder."

The 1988 ACPA computer program (15) was used to evaluate the effects of various values for J and results are shown in Figures 39-42 for 9-inch through 12-inch portland cement concrete pavements respectively. Note that the same CBR has been chosen and that the thickness of the pavement has been assigned a specific EAL. Figures 39, 40, and 42 show that approximately the same terminal serviceability is calculated for a fixed percent reliability. Figure 41 indicates a slightly larger terminal serviceability and may be more related to the EAL that may be higher than it should be for the CBR and thickness. Even so, Figure 43 illustrates the results of averaging the terminal serviceabilities for Figures 39-42 for each respective combination of percent reliability and value of J.

Observations indicate that for most of Kentucky's pavements having paved shoulders (asphalt or concrete), many trucks travel right on the edge of the pavement and quite often on the shoulder itself. Therefore, the recommended value for J is 3.1 for use in designing tied shoulders in Kentucky.

Kentucky routinely uses tied concrete shoulders for all high type concrete pavement construction. The above analyses will enable the Division of Design to quantify the potential benefits of tied concrete shoulder pavements.

REHABILITATION

Chapter 1, Part III (1) contains introductory discussions. Chapter 2 presents rehabilitation concepts and Figure 2.3 (1) contains a list of items to be considered in evaluating a pavement project for rehabilitation. Items to be evaluated include:

1. Structural (pavement, not bridge)
2. Function (highway functional class designation)
3. Variation in conditions
4. Climatic effects (edge drains)
5. Pavement materials
6. Subgrade
7. Maintenance history
8. Traffic control during construction
9. Geometrics and safety
10. Traffic loadings
11. Shoulder conditions

Almost all items, if not all, are considered by the various Divisions within the Department of Highways for those subjects falling within their responsibilities.

Non Destructive Testing (NDT) is recommended for evaluating an existing pavement. Kentucky's methods for NDT testing and evaluation are more advanced than those suggested in the Guide (1).

Chapter 3 (1) is titled, "Guides for Field Data Collection." The recommended types of data collection activities are:

1. Drainage survey
2. Condition distress survey -- specific distresses are listed in Table 3.2 for asphalt pavements and Tables 3.3 and 3.4 for rigid pavements.
3. NDT deflection measurements
    a. In situ structural capacity
    b. Rigid pavement joint/load transfer analysis, and
    c. Rigid pavement slab-void detection.

Note that pavement roughness and rideability surveys are not included.

Chapter 4 covers rehabilitation methods other than overlays. Tables 4.1 and 4.2 (1) list candidate repairs and preventive methods for rigid and flexible pavement distresses, respectively. In summary, repair methods for items in Tables 4.1 and 4.2 have been tried, or are in routine usage, in Kentucky.

Chapter 5 (1) covers rehabilitation methods with overlays. Seven steps listed in the development of design input factors are:

1. Analysis unit delineation
2. Traffic analysis
3. Materials and environmental study
4. Effective structural capacity analysis
5. Future overlay structural capacity analysis
6. Remaining life factor determination, and
7. Overlay

The first five items above are a part of Kentucky's current procedures.

Items 6 and 7 are combined as a part of the overlay design methodology, particularly for flexible pavements. The Kentucky method for overlay design thickness for flexible pavements is the difference between the structural capacity of the existing pavement and the required structural capacity to address future traffic and vehicle loadings. The 1986 AASHTO Guide references several approaches for overlay design including non-destructive pavement testing, the use of visual condition evaluation data, and the use of accumulated and projected traffic and vehicle loading data. The structural capacity of existing pavements in Kentucky currently is determined on the basis of deflection testing. Overlay thickness estimates are determined on the basis of an effective thickness approach wherein the effective thickness is determined from deflection tests. On thick overlays (greater than 2.5 inches), additional analyses are conducted on the basis of accumulated and projected traffic and visual condition surveys. For flexible overlays on rigid pavements, techniques listed are:

1. Use of thick AC overlays -- this method is proposed "to minimize reflective cracking." Kentucky experience indicates increasing the thickness only delays the inevitable reflected crack.
2. Break and seat approach -- Kentucky is recognized as a leader in this area.
3. Saw cutting matching transverse joints in overlay
4. Use of crack relief layers (special open-graded asphalt mixes) -- at least two overlay construction projects contain this technique.
5. Stress-absorbing membrane interlayers with the overlay -- Kentucky has tried this procedure with varying degrees of success.
6. Fabric membrane interlayers with the overlay. For this procedure, Kentucky experience indicates the method can be successful provided movement of the slabs is horizontal. Vertical differential movement at joints destroys (tears) the fabric.

For rigid overlays on existing rigid pavements, the three types are full bond, partial bond, and unbonded. Kentucky has considered using each of these. To date, only one project of a concrete overlay nature has been constructed in Kentucky. This project involved constructing a 9-inch PCC overlay over a 4-inch bituminous drainage and separation layer over an existing rubblized CRCP pavement. This is not an overlay in the classical sense in that it involved construction of a new concrete pavement over an existing CRCP pavement which was recycled inplace.

In a section titled "Special Overlay Considerations, the following items are listed:

1. Pavement widening
2. Full lane additions
3. Use of recycled materials
4. Partial reconstruction/grinding/milling
5. Pre-overlay rehabilitation improvements:
   a. large patches to replace cracked areas
   b. full-depth repairs
   c. slab replacement
   d. tied PCC shoulders.

Kentucky has tried, or utilized, the first four items as appropriate situations arise. For item 5, most of these activities usually are not considered except that tied concrete shoulders have been constructed on at least one project. For rigid pavements, actions listed under item 5 are not appropriate when crack and seat repairs are made.

COMPARISON OF PAVEMENT THICKNESS DESIGNS

Any new or different method for determining pavement thickness designs should be compared with those based upon experience. A comparison has been made using:

1. 1981 Kentucky Thickness Design Curves,
2. 1987 Kentucky Thickness Design Curves, and
3. 1986 AASHTO Design Guide for serviceability levels of 3.5, 3.0, 2.5, 2.0, and 1.5.

The Kentucky thickness designs were converted to structural number, SN, using 0.44 and 0.14 for coefficients a_1 and a_2, respectively. The comparisons are provided in Tables A1 through A7 in Appendix A of this report.

For a given subgrade, the 1981 and 1987 Kentucky thickness design curves were superimposed on thickness design curves obtained for various degrees of reliability. This comparison was made for each of three values of subgrade (CBR 3, 6, 10 for M_r 2,078-, 3,283-, and 4,598 psi, respectively) and three serviceability levels (P_t of 2.0, 2.5, and 3.0) as shown in Figures B1-B9 of Appendix B of this report. Figure B10 contains the 1981 and 1987 Kentucky thickness design curves for CBRs 3, 6, and 10 superimposed on a family of curves from the 1986 AASHTO design equation for P_t 3.0 and 50-percent reliability. On some ends of the 1987 Kentucky curves, a segment may be at an angle different from the majority of the length of the curve and occur in areas of extrapolation beyond the data to which the curve was fitted. This phenomenon occurs because the curve was created using the Lagrangian curve-fitting routine. This procedure provides a very good fit in the range of data points, but will diverge for zones of extrapolation -- as is the case here. Therefore, extrapolation areas should be viewed with caution and good judgment.

Appendix C contains figures on which the 1987 Kentucky design curve corresponding to CBR 5.2 has been superimposed on a family of percent reliability curves derived from the 1986 AASHTO Design equation. A Kentucky CBR 5.2 subgrade corresponds to a soil support value of 3.0 determined to represent the soils used at the AASHO Road Test. Each figure is for a specific serviceability level. Note that the Kentucky curve essentially parallels the family of percent reliability curves for serviceability levels of 1.5, 2.0, and 2.5. The Kentucky curve crosses slightly through the family of curves for P_t of 3.0 and rather prominently through the curves for P_t of 3.5. The change in pattern required verification that is provided in Appendix D.

Appendix D contains figures similar to those in Appendix C. The weighted fatigue data of Appendix A of reference 2 and shown in Figures 25-29 in this report were used to verify the fit of curves shown in Appendix C. In addition, a straight-line log-log least-squares regression was fitted to the data. The same family of percent reliability curves from figures in Appendix C were superimposed also. Behavior noted in the figures of Appendix C were noted in the figures of Appendix D. For serviceability levels of 3.0 and 3.5, a 50% reliability curve does not correspond to the least squares regression line through the same data from which the AASHTO design equation was derived. Therefore, the designer should use the 1986 AASHTO Design Guide with caution for pavement designs having serviceability levels above 2.5.

The Division of Design requested a comparison of design thicknesses using an expanded set of EALs and a different combination of AASHTO layer coefficients than those used to create the tables in Appendix A. The additional Tables comparing thickness designs obtained from the 1981 Kentucky (5) and 1987 Kentucky (11) thickness design systems with those obtained using the 1988 ACPA computer program (15) are presented in Appendix E. Equations used to convert structural number, SN, to total thickness are presented in Appendix E.

SUMMARY

The primary purpose for this study is to evaluate the sensitivity of 14 variables that were included in the 1986 AASHTO Design Guide for Pavement Structures. States were encouraged to conduct further research to match conditions within the state. A few of these items were omitted from this study because they were covered under other studies, or were already addressed by other procedures in Kentucky design methods.

Study findings are:

1. Variations in percent reliability are quite large whereas the effects of variations in standard error are minimal.
2. Use of the resilient modulus for soil support value or Kentucky CBR may be valid. Users should be aware of the differences in magnitudes and the interrelationships.
3. Resilient modulus for the various flexible pavement layer

coefficients has not been defined sufficiently for use at this time. Values that have been used previously should continue to be used and may be modified to account for changes in moisture conditions.

4. Perhaps drainage is the best defined innovation included in the guide. Field verification is needed prior to use. Permeability data may be the source of data to best define appropriate values.
5. In the area of improved environmental considerations, the variation in subgrade moduli throughout the year has less effect than effects of pavement temperature upon the stiffness of the asphaltic concrete. The Guide does not include temperature effects. The next update to the Guide should include information relative to effects of temperature.
6. Sensitivity analyses were made for the recommended range of values for the load transfer coefficient, J. Figure 43 illustrates the relationship between percent reliability, J, and terminal serviceability. Based on observations of where trucks travel within the outside lane, a value of 3.1 is recommended for use in Kentucky.
7. In the area of subbase erosion for rigid pavements, data presented in Table 54 (1) indicate that the volume of material pumped from under slabs at edges and joints appears to be a function of the number of individual axles passing over that spot and not the number of axle groups. A tandem axle group is similar to one application of load to the pavement for fatigue. A tandem affects joint pumping as the application of two loads to the pavement.
8. Life cycle cost considerations are the subject of another research study and were omitted from this study.
9. Pavement management was the subject of another study.
10. Extension of load equivalency values has been investigated. The same equation was used to develop factors for higher loads, a level of serviceability of 3.0, and for tridem axle groups by the insertion of a value of 3 for L_x. No relationship has been included to account for unequal load distribution between the individual axles within the group. Loadometer data and WIM data indicate that only 12 percent of all tandems and tridems distribute the load equally to all axles within a group. No factors are included to account for changes in contact pressures at the tire-pavement interface. Relationships have been developed in Kentucky for these variables and they have been used to verify the time of pavement failures during forensic studies. Load equivalency factors have been developed to account for a two-tired axle within a group of axles, each having four tires.
11. The Planning Division employees have been collecting data for many years using a traffic data collection plan. With implementation of the FHWA Traffic Monitoring Guide, these collection efforts will result in more comprehensive data--especially with the incorporation of WIM equipment.

12. No effort has been made to investigate the design of pavements for low volume roads because Kentucky's design curves have always extended to a design EAL of 7,300--the equivalent of one pass of an 18-kip axleload per day for 20 years. The 1986 AASHTO Guide has a limiting minimum value of 50,000 EAL. The 1986 AASHTO Guide also refers to low volume roads as those with ESAL;s of 700,000 to 1,000,000 over the design life. These design levels are well within the range of the Kentucky design curves.
13. The application of mechanistic principals has been the foundation for Kentucky pavement thickness design curves since 1968 and is recognized as such in Part III (1). Other design systems based on mechanistic principals are Shell Oil, Mobil Oil, The Asphalt Institute, Illinois, and Texas.
14. Almost all rehabilitation methods and procedures listed in the Guide (1) are being used by Kentucky Department of Highways. Those not used have been replaced by methods that better fit Kentucky conditions, or have been tried but found to be unsuccessful, or not economical. Roughness surveys have been used by Kentucky DOH for years but this type of survey is not mentioned in the 1986 Guide (1).

In summary, there are variables introduced in the Guide that require additional research and verification for application to individual states. A portion of the required research currently is being done for Kentucky conditions under other studies.

RECOMMENDATIONS

Recommended courses of action are:

1. The Kentucky Department of Highways should continue to use the Kentucky thickness design curves that have been developed and correlated to Kentucky conditions.
2. The 1986 AASHTO Guide may be used to:
   a. compare thickness designs using materials that might be different from the usual materials for which the Kentucky design curves are applicable.
   b. to quantify the effects of changing levels of reliability, standard deviation, seviceability, etc.
   c. to provide a mechanism for adjusting thickness designs to address other special situations, etc.

The following items need further sensitivity analyses.

1. Additional research to define moduli of base materials.
2. Further advancements in the mechanistic approach are needed for both AASHTO AND Kentucky methods. Topics include:

   AASHTO Method:

   a. The Structural Number concept can be improved by developing relationships for layer coefficients as a function of thickness of other layers

and work at the top of the subgrade. Graphs of fatigue versus structural number for AASHO Road Test data indicate that the scatter in structural number can be reduced to approximately 10 to 15 percent of the original scatter based on modification of coefficients based on work at the top of the subgrade.
b. Straight line log-log regression equations fit the AASHO Road Test data better than the AASHTO equations used for thickness designs.

Kentucky Method:
a. The first required modification is to develop moduli relationships for various combinations of materials when supported by analyses of test data. Field deflection test data are being obtained under study KYHPR-86-115. These tests will provide the data required to develop some of the above relationships.

b. Other modifications may be made such as developing relationships to apply reliability concepts to the methodology.

c. The methodology may be altered to provide the capability of determining a thickness design for any desired proportion of asphaltic concrete to crushed stone, or a multi-layer approach.

LIST OF REFERENCES

1. AASHTO Guide for Design of Pavement Structures, 1986, American Association of State Highway and Transportation Officials, Washington, D.C., 1986.
2. AASHO Road Test: Report 5 -- Materials and Construction, Highway Research Board, Washington, D. C., 1962.
3. 1972 AASHTO Interim Guide for Design of Pavement Structures, American Association of State Highway and Transportation Officials, Washington, D C., 1972 (1982 Printing).
4. W. B. Drake and J. H. Havens, "Kentucky Flexible Pavement Design Studies," Bulletin No. 4, Vol 13, Engineering Experiment Station, University of Kentucky, Lexington, KY, June 1959.
5. J. H. Havens, R. C. Deen, and H. F. Southgate, "Design Guide for Bituminous Concrete Pavement Structures," Research Report UKTRP-81-17, Kentucky Transportation Research Program, College of Engineering, University of Kentucky, Lexington, KY, August 1981.
6. T. A. Middlebrooks and G. E. Bertram, "Soil Tests for Design of Runway Pavements", Proceedings, Highway Research Board, Washington, D. C., 1942.
7. H. F. Southgate and R. C. Deen, "Temperature Distributions in Asphaltic Concrete Pavements," Record 549, Transportation Research Board, Washington, D. C., 1975.
8. H. F. Southgate and R. C. Deen, "Effects of Load Distributions and Axle and Tire Configurations on Pavement Fatigue," Proceedings, Sixth International Conference, Structural Design of Asphalt Pavements, University of Michigan, Ann Arbor, MI, 1987; also Proceedings, Second National Weigh-in-Motion Conference, Vol One, Atlanta, GA, 1985.
9. H. F. Southgate, "Estimation of Equivalent Axleloads Using Data Collected by Automated Vehicle Classification and Weigh-In-Motion Equipment," Research Report KTC-90-11, Kentucky Transportation Center, College of Engineering, University of Kentucky, Lexington, KY, June 1990.
10. H. F. Southgate, R. C. Deen, D. H. Cain, and J. G. Mayes, "Modification to Chevron N-Layer Computer Program," Research Report UKTRP-87-28, Kentucky Transportation Research Program, College of Engineering, University of Kentucky, Lexington, KY, October 1987.
11. H. F. Southgate, R. C. Deen, J. H. Havens, and W. B. Drake, Jr., "Kentucky Research: A Flexible Pavement Design and Management System," Proceedings, Fourth International Conference, Structural Design of Asphalt Pavements, University of Michigan, Ann Arbor, MI, 1977.
12. H. F. Southgate and R. C. Deen, "Distributions of Strain Components and Work within Flexible Pavement Structures," Research Report UKTRP-86-21, Kentucky Transportation Research Program, College of Engineering, University of Kentucky, Lexington, KY, September 1986.
13. H. F. Southgate and R. C. Deen, "Thickness Design Curves for Portland Cement Concrete Pavements," Research Report UKTRP-84-3, Kentucky Transportation Research Program, College of Engineering, University of Kentucky, Lexington, KY, February 1984.

14. Simplified Guide for the Design of Concrete Pavements, American Concrete Pavement Association, Arlington Heights, IL, 1988.
15. H. F. Southgate and R. C. Deen, "Pavement Designs Based on Work," Research Report UKTRP-87-29, Kentucky Transportation Research Program, College of Engineering, University of Kentucky, Lexington, KY, October 1987.

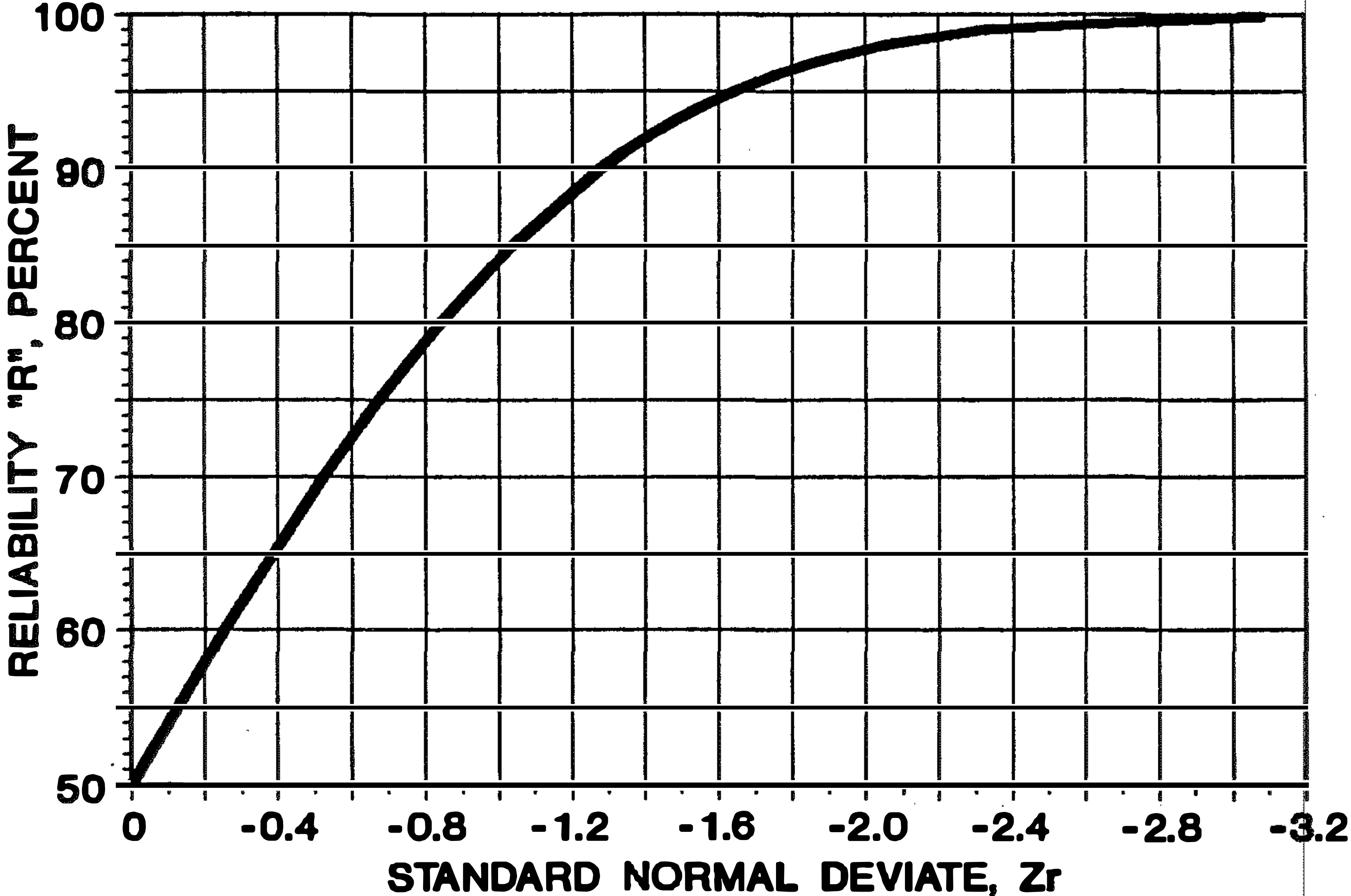


Figure 1. Relationship between Standard Normal Deviate, Zr, and Reliability.

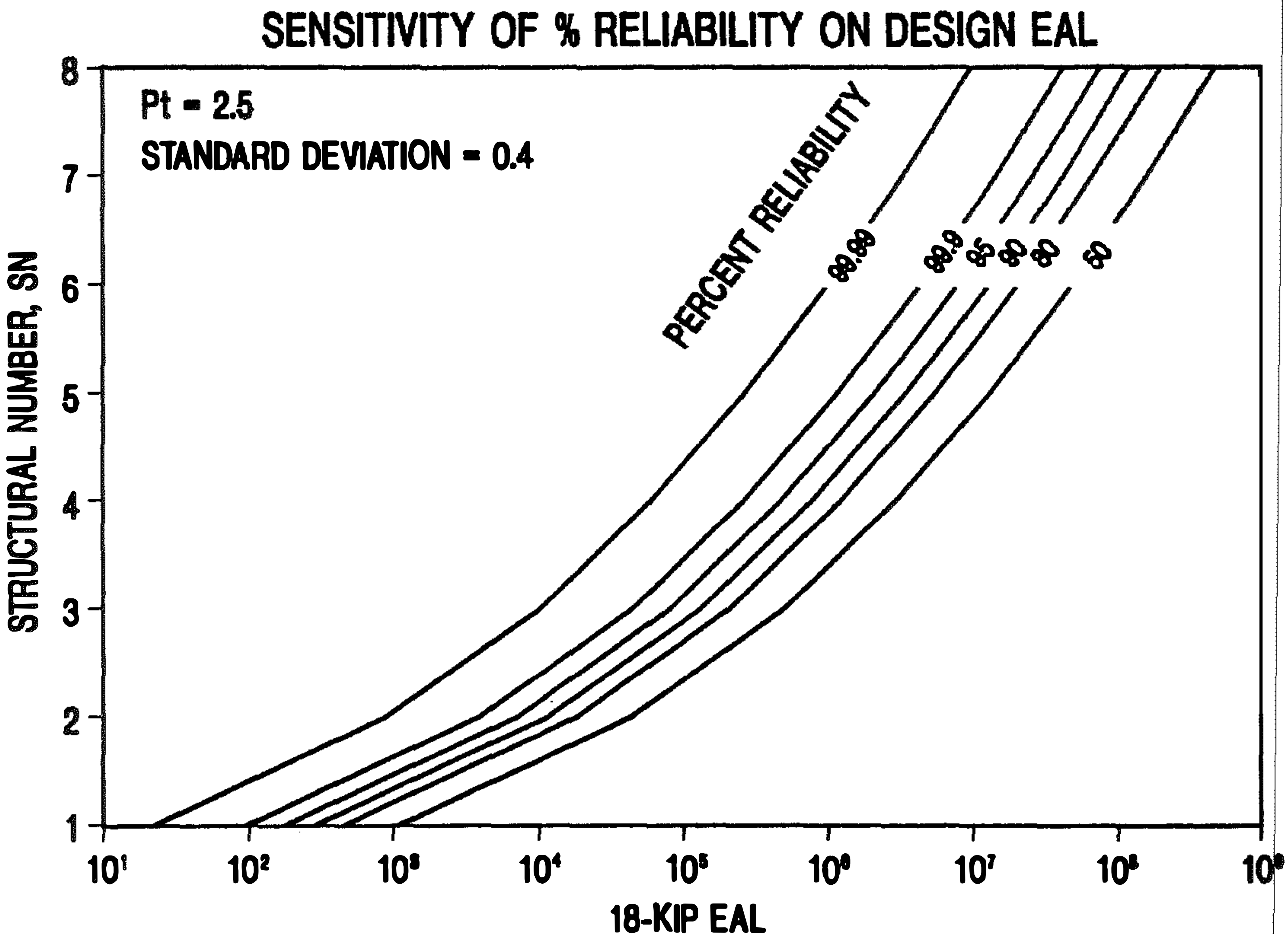


Figure 2. Relationship between 18-kip EAL and Structural Number for Various Values of Percent Reliability.

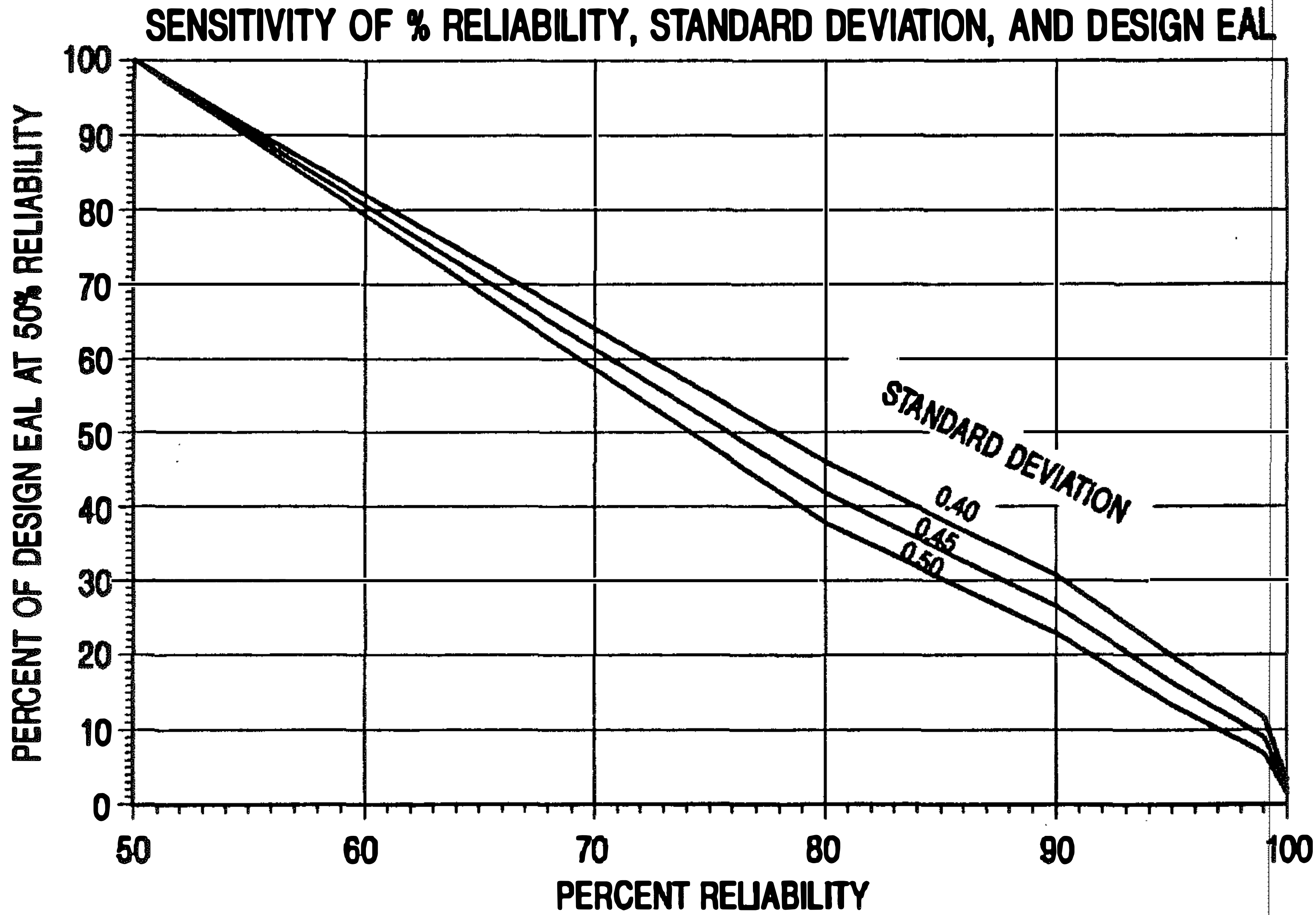


Figure 3. Relationship between Percent Reliability and Percent of Design EAL at 50 Percent Reliability as a Function of Standard Deviation.

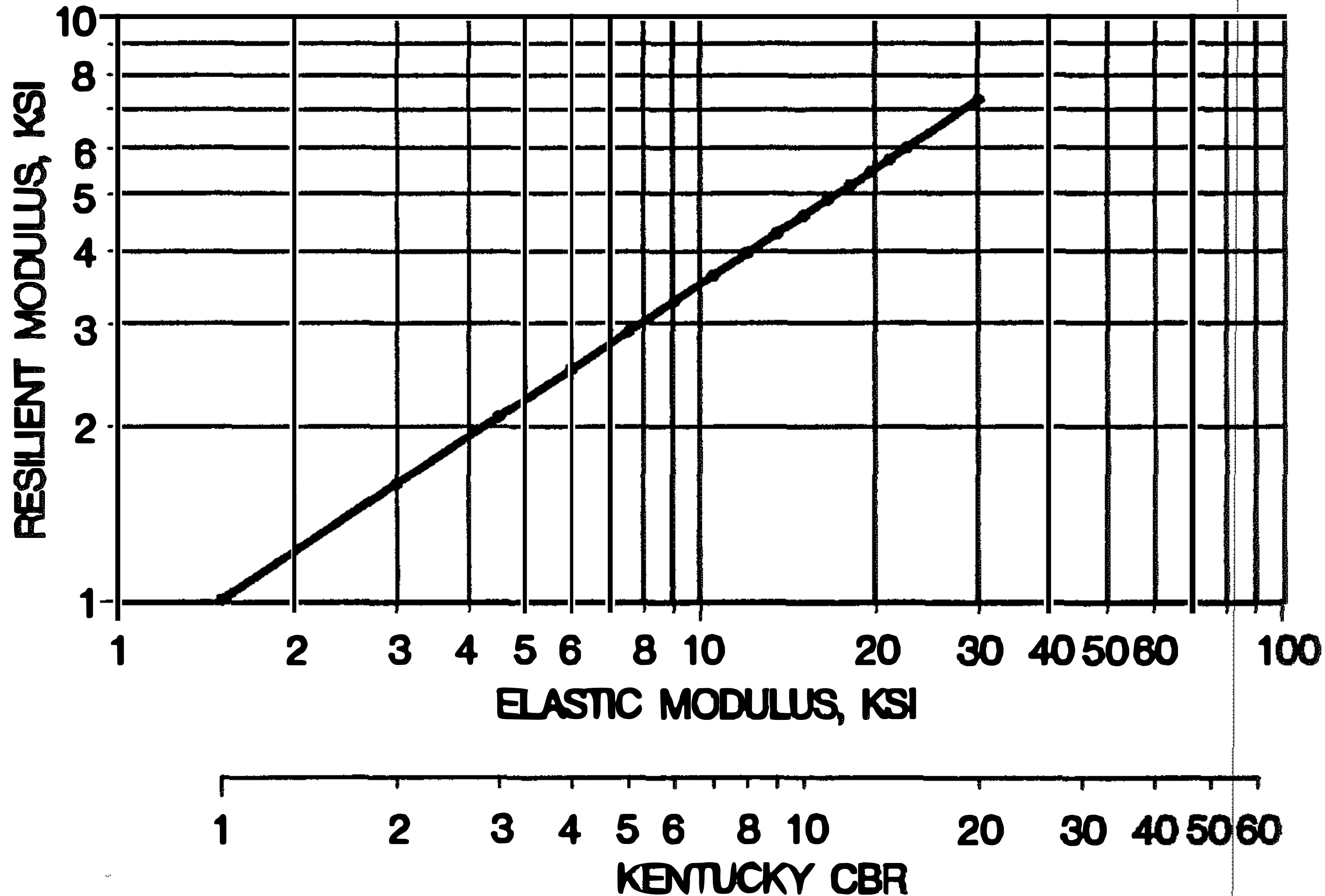


Figure 4. Relationship between Kentucky CBR, Elastic Modulus, and Resilient Modulus.

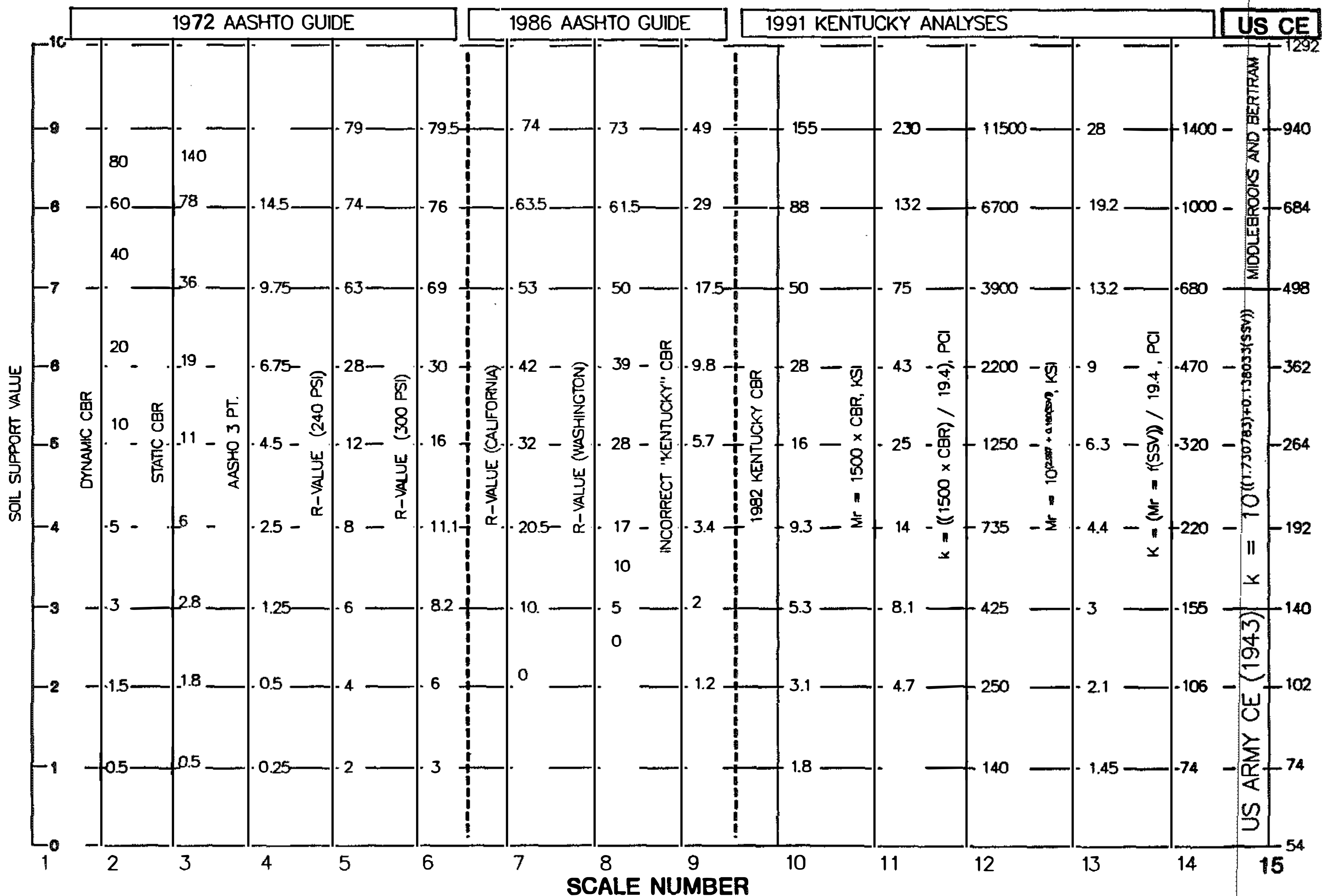


Figure 5. Relationship between Soil Support Value, R-Value, CBR, Subgrade Resilient Modulus According to both Kentucky and AASHTO, and k-Value Used in Rigid Pavement Thickness Designs.

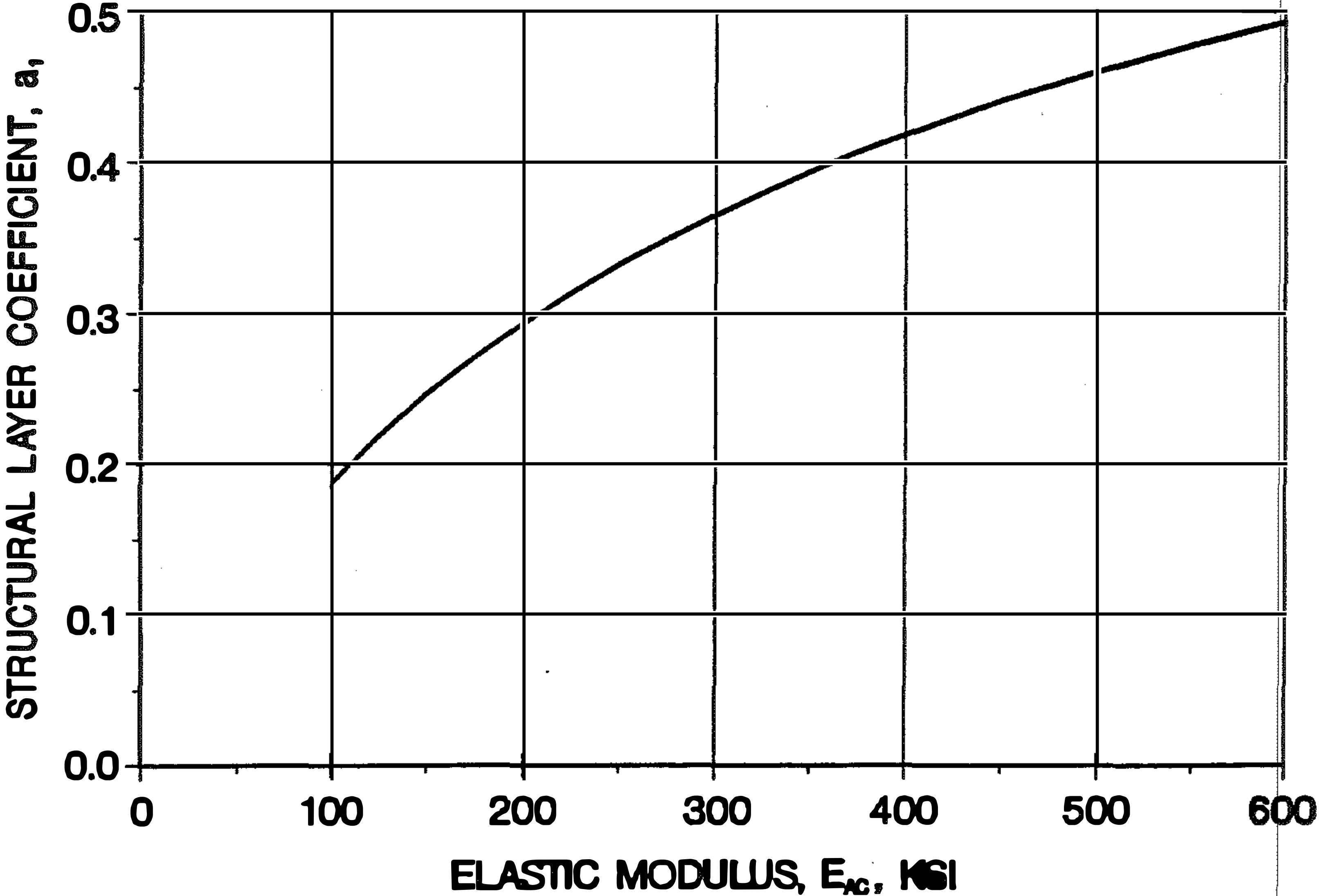


Figure 6. Relationship between Elastic Modulus for Asphaltic Concrete and Structural Coefficient a_1.

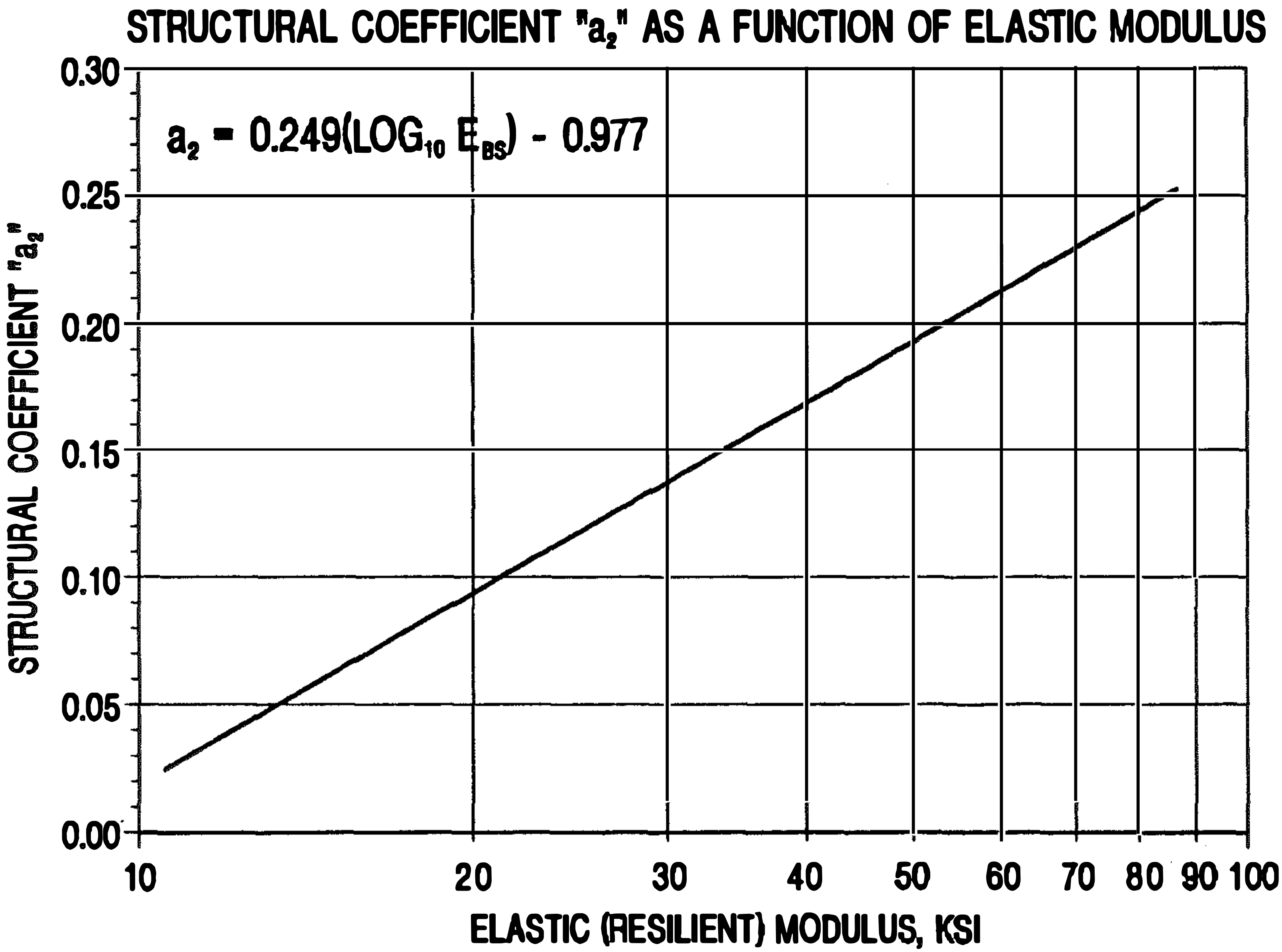


Figure 7. Relationship between Elastic Modulus for Asphaltic Concrete and Structural Coefficient a_2.

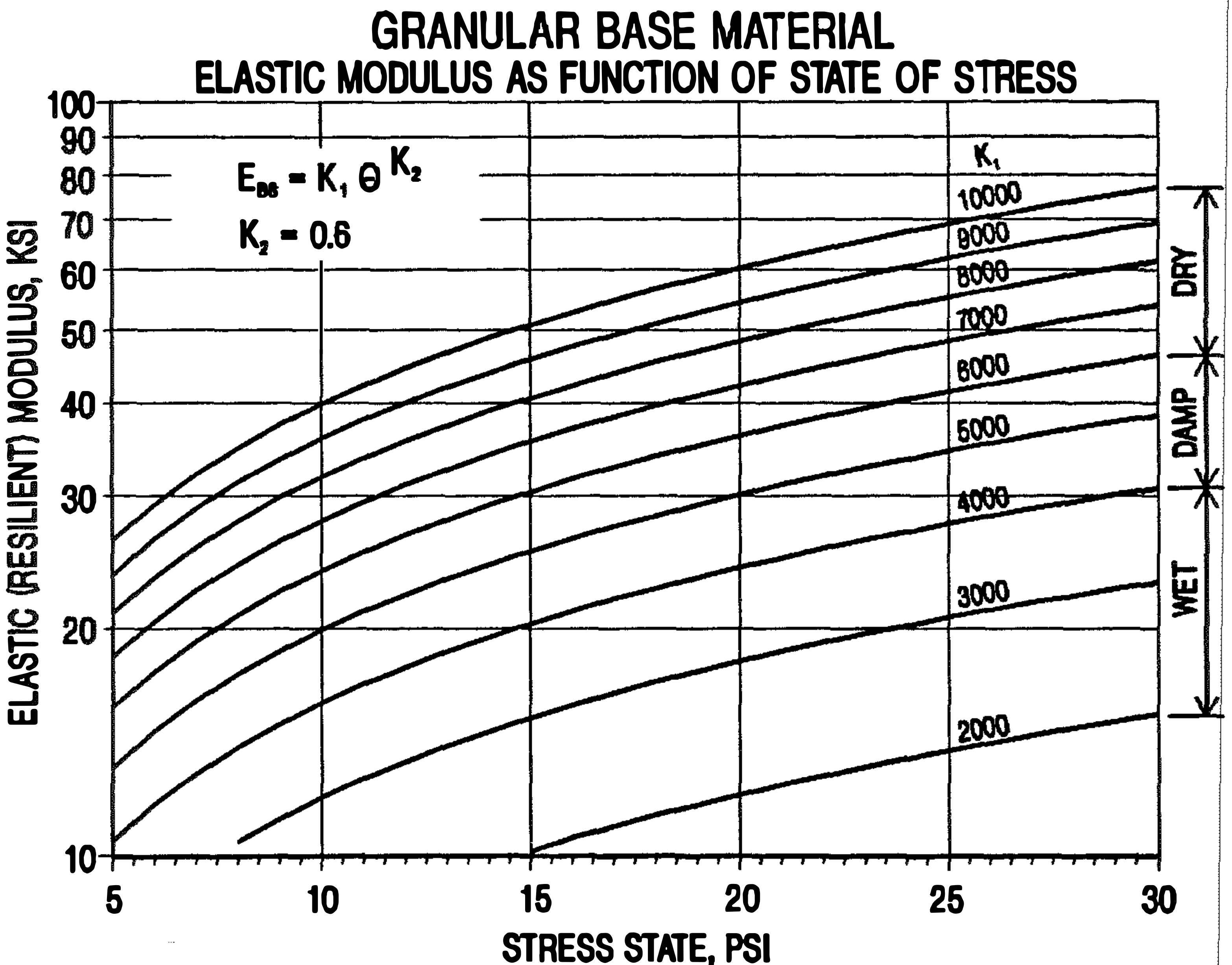


Figure 8. Relationship between Stress State and Elastic (Resilient) Modulus for K_1 Base Material.

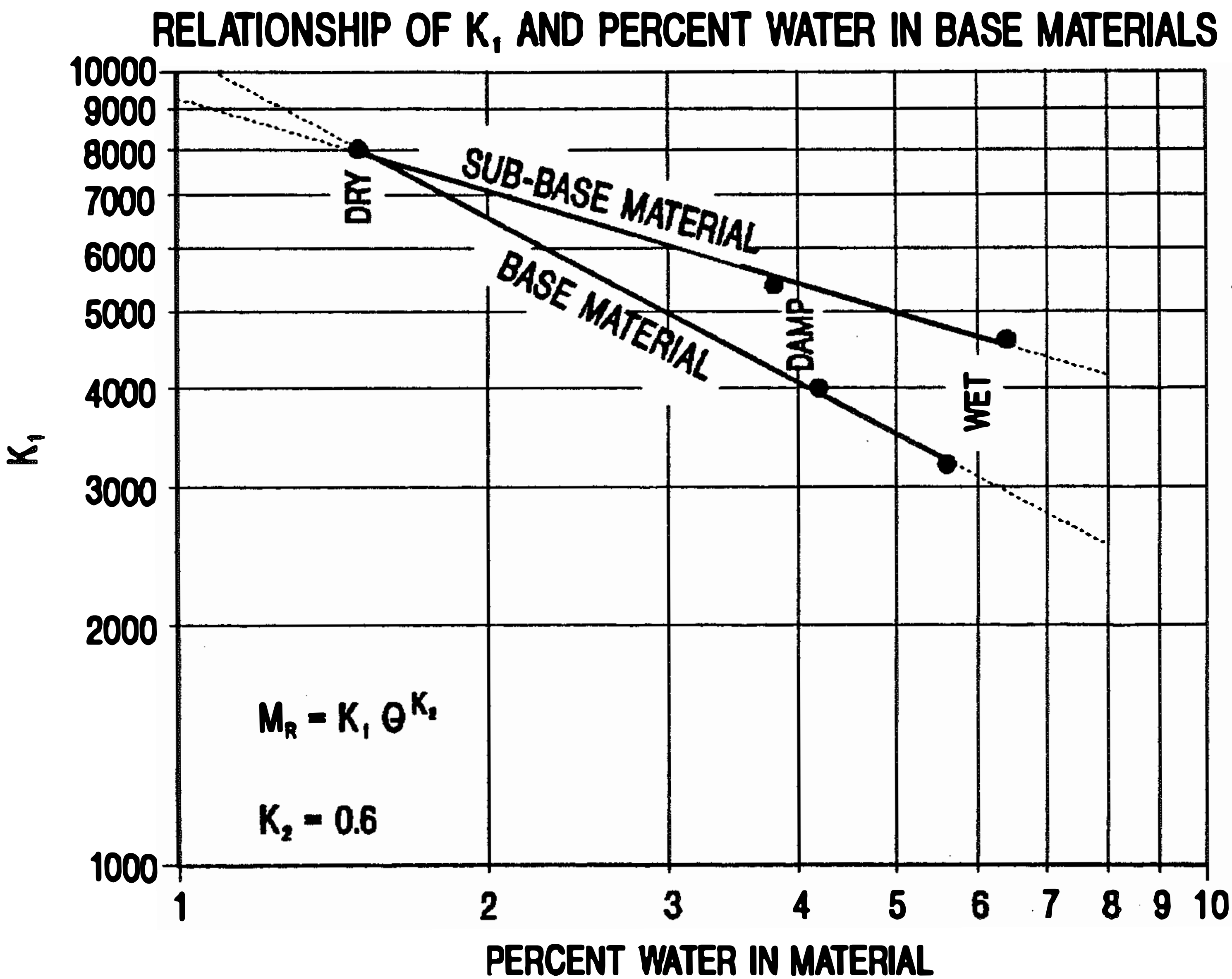


Figure 9. Relationship between Percent Water and K_1 for Base Materials.

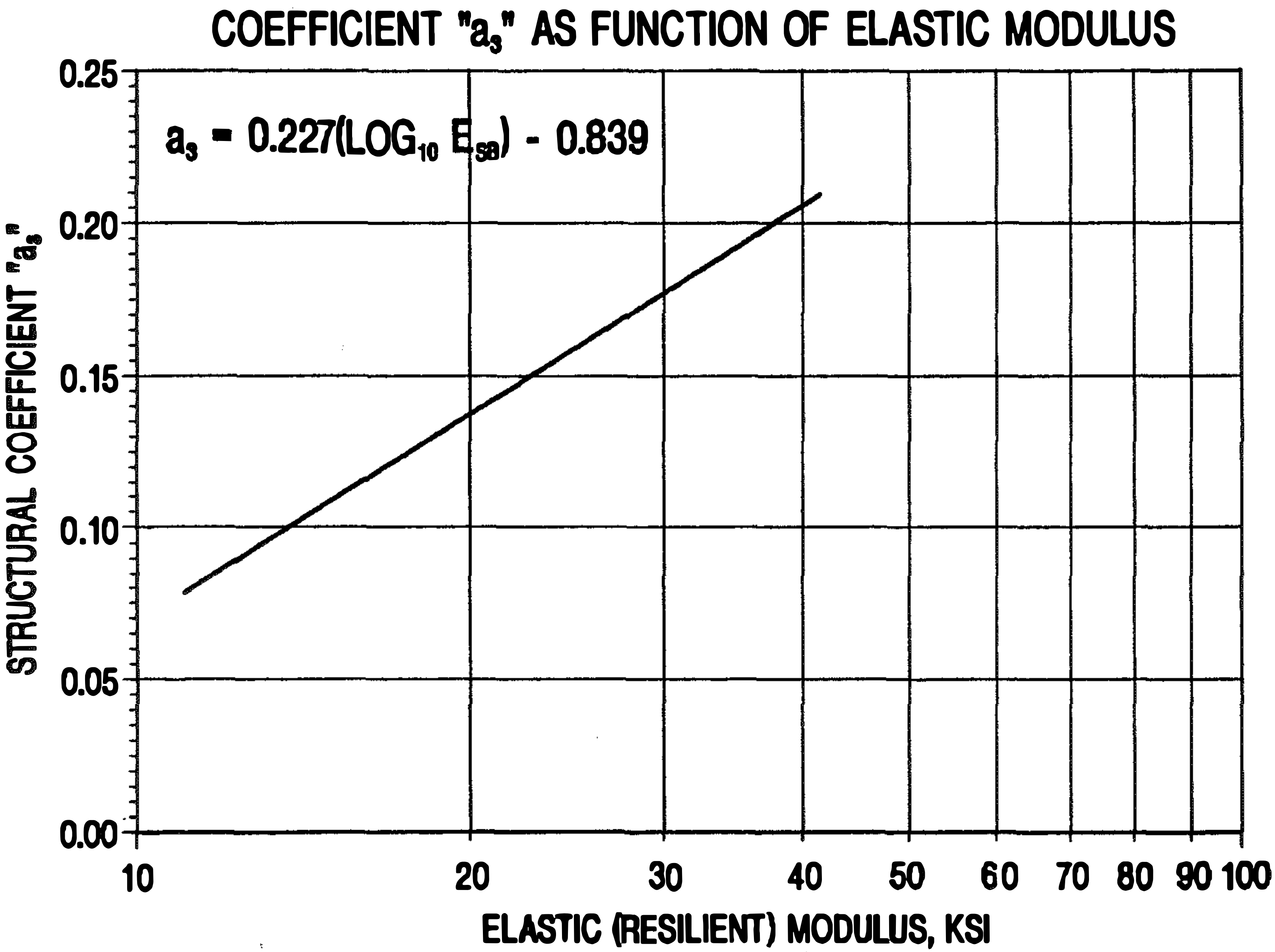


Figure 10. Relationship between Elastic Modulus for Asphaltic Concrete and Structural Coefficient a_3.

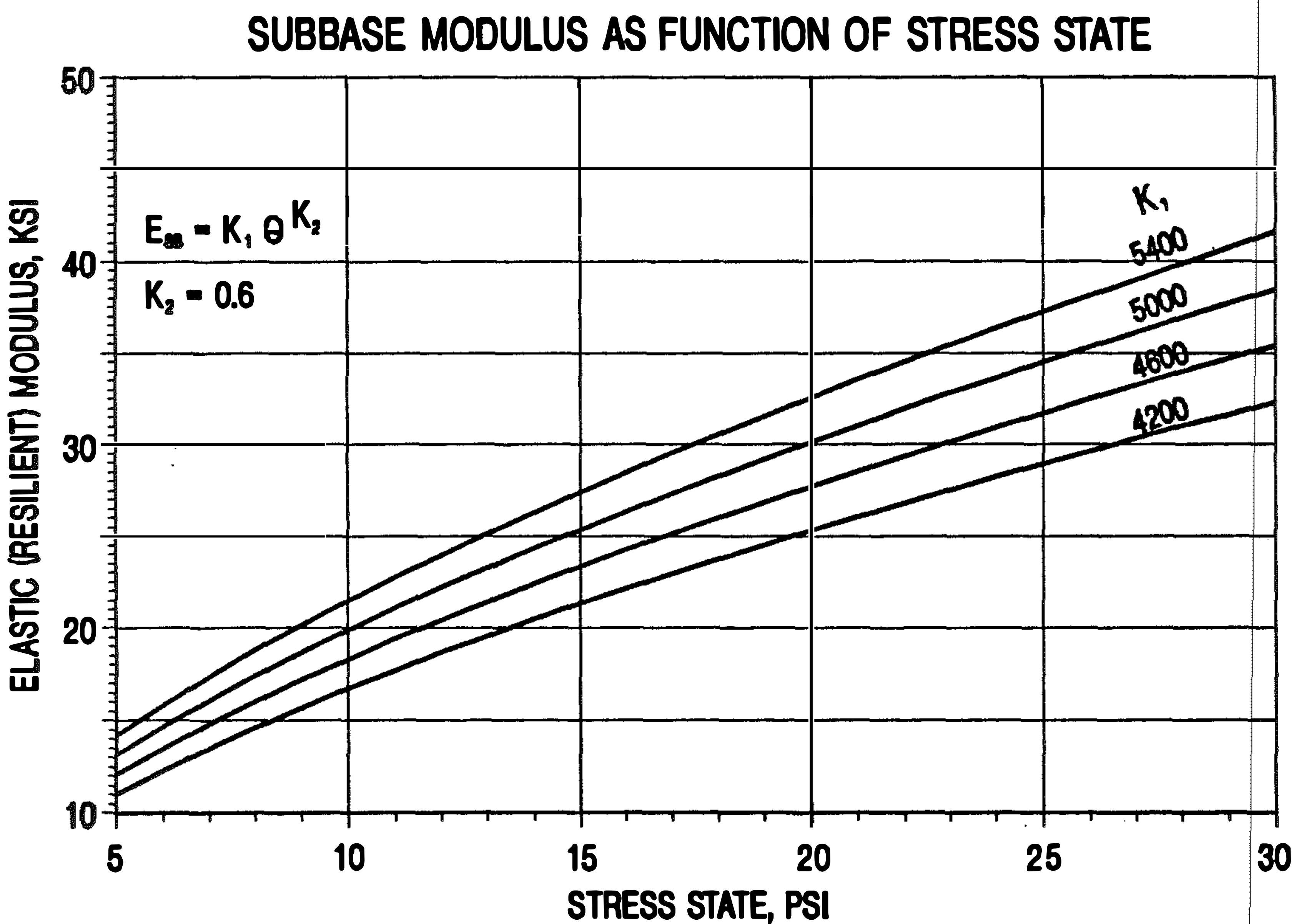


Figure 11. Relationship between Stress State and Elastic (Resilient) Modulus for K_1 for Subbase Material.

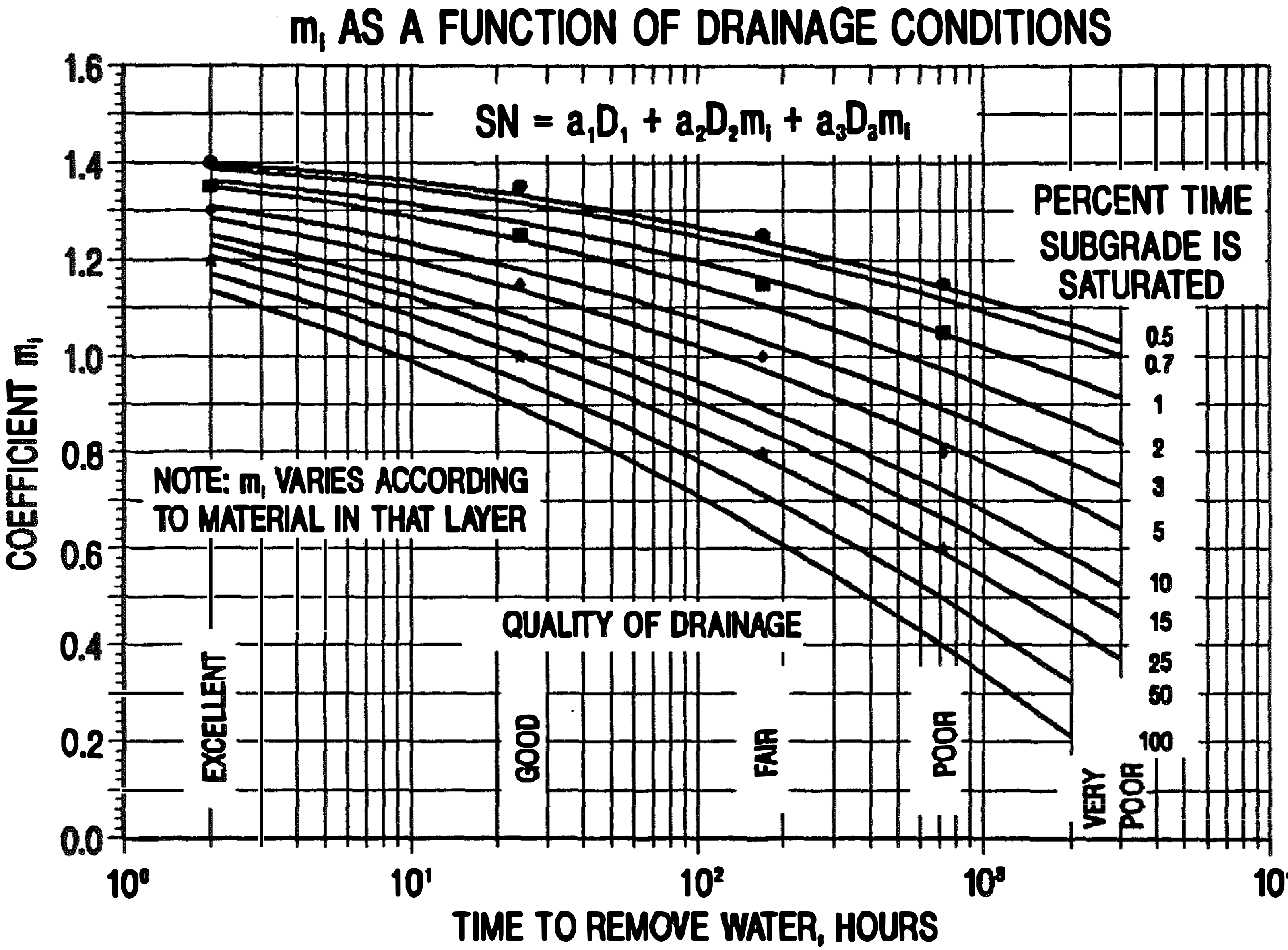


Figure 12. Relationship between Time to Remove Water from Base Materials and Coefficient m_1 for Flexible Pavements.

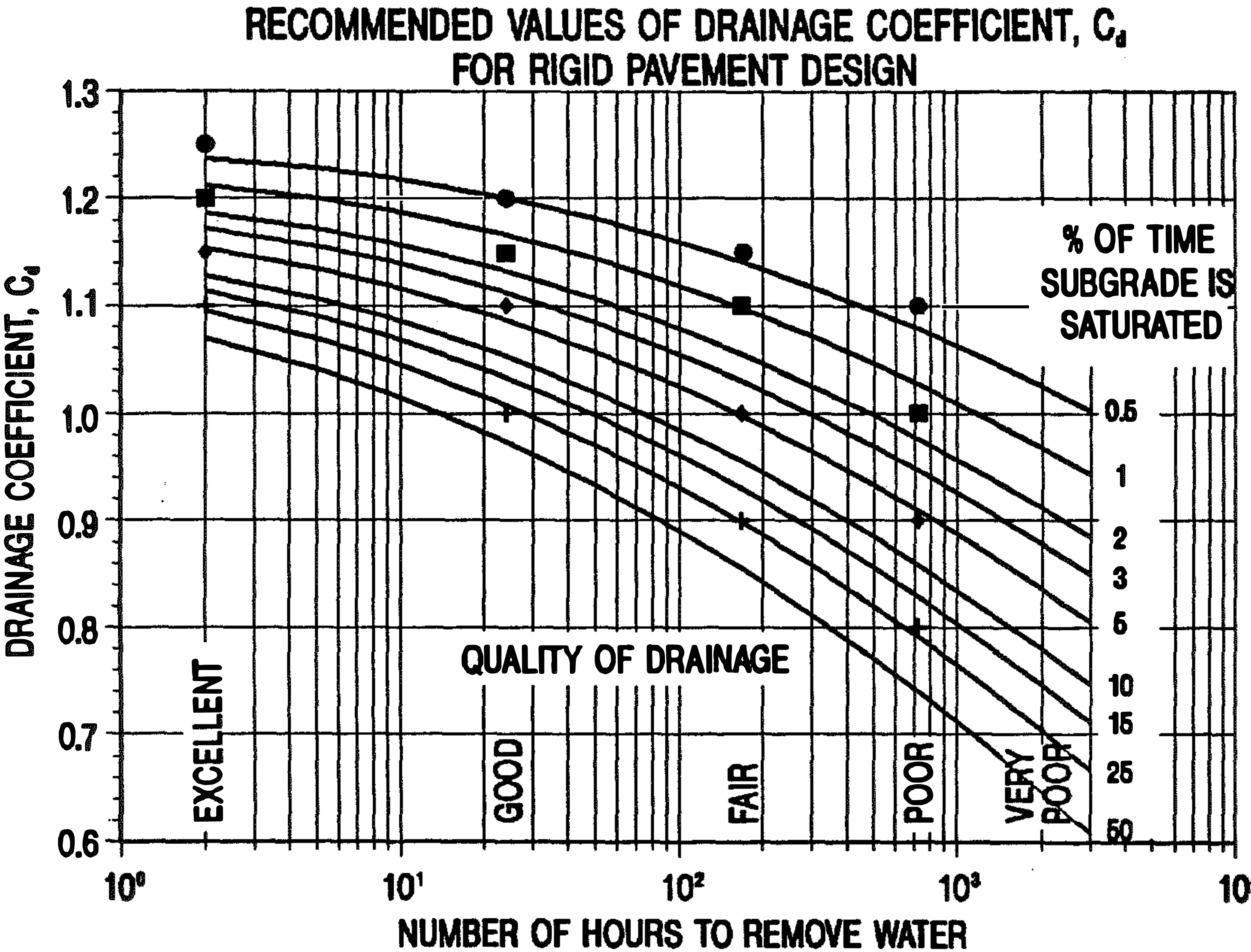


Figure 13. Relationship between Time to Remove Water from Base Materials and Drainage Coefficient, c_d for Rigid Pavements.

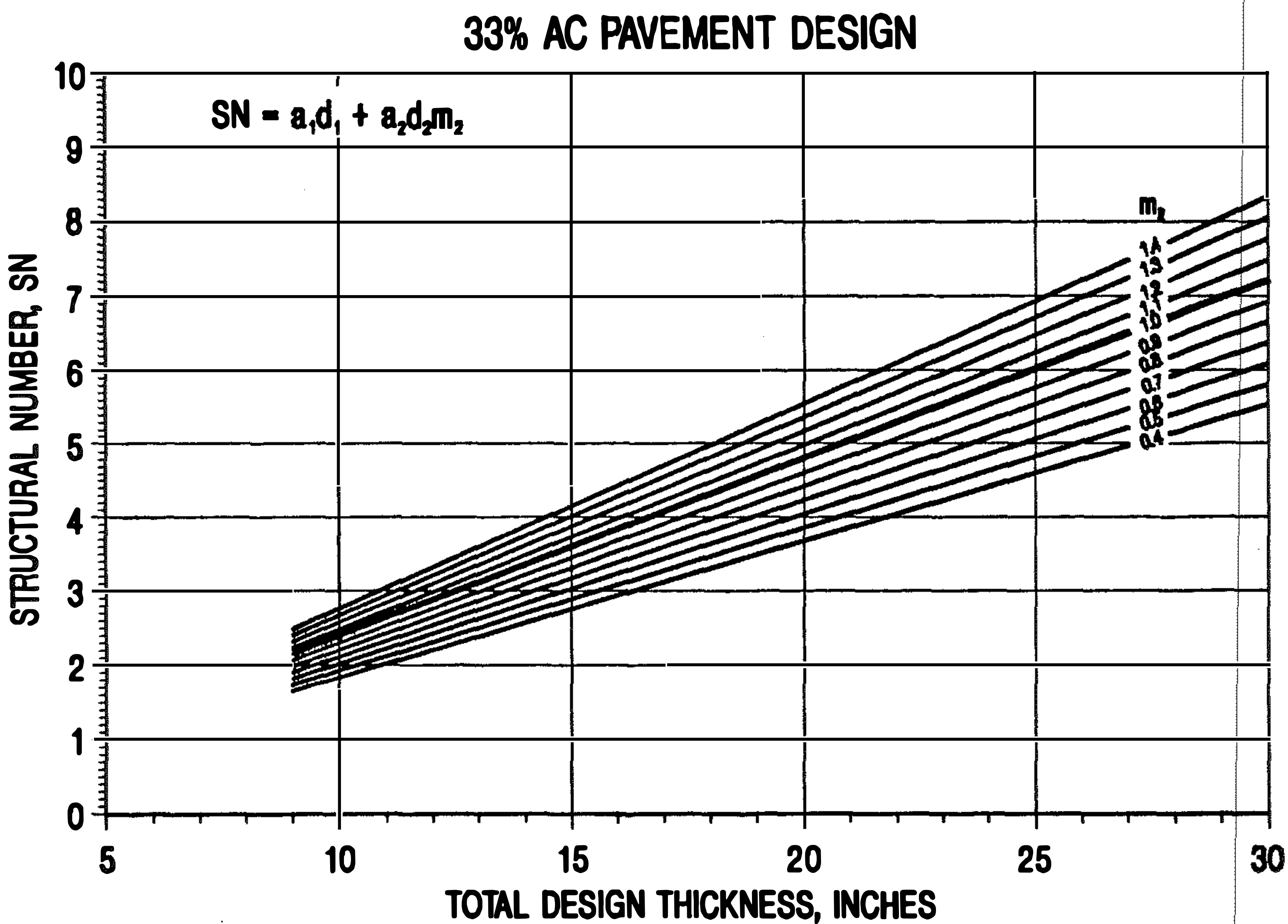


Figure 14. Total Design Thickness in Inches Expressed as Structural Number for Pavements Whose Thickness of Asphaltic Concrete is 33 Percent of the Total Thickness.

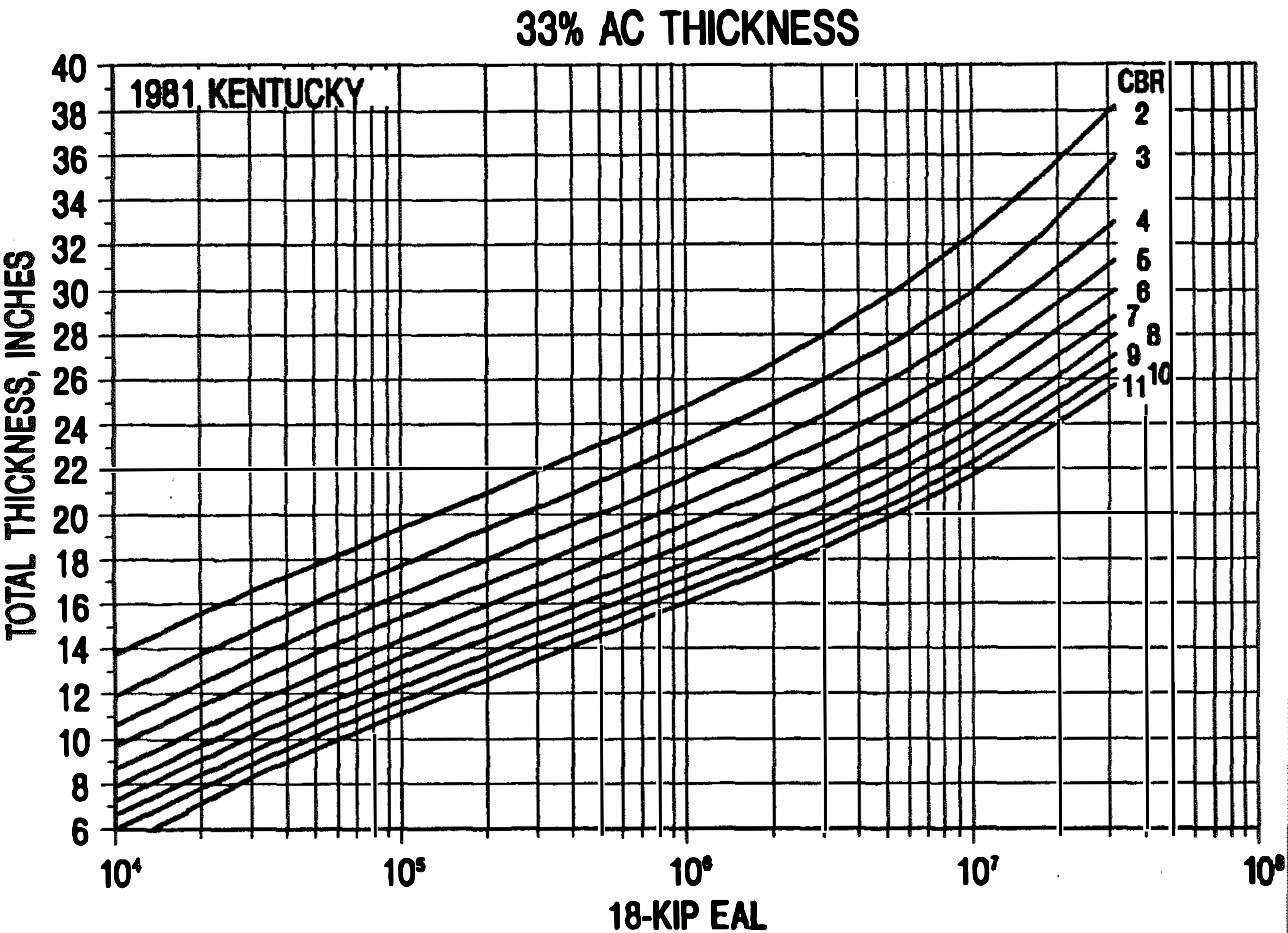


Figure 15. 1981 Kentucky Flexible Pavement Thickness Design Curves Whose Thickness of Asphaltic Concrete is 33 Percent of the Total Thickness.

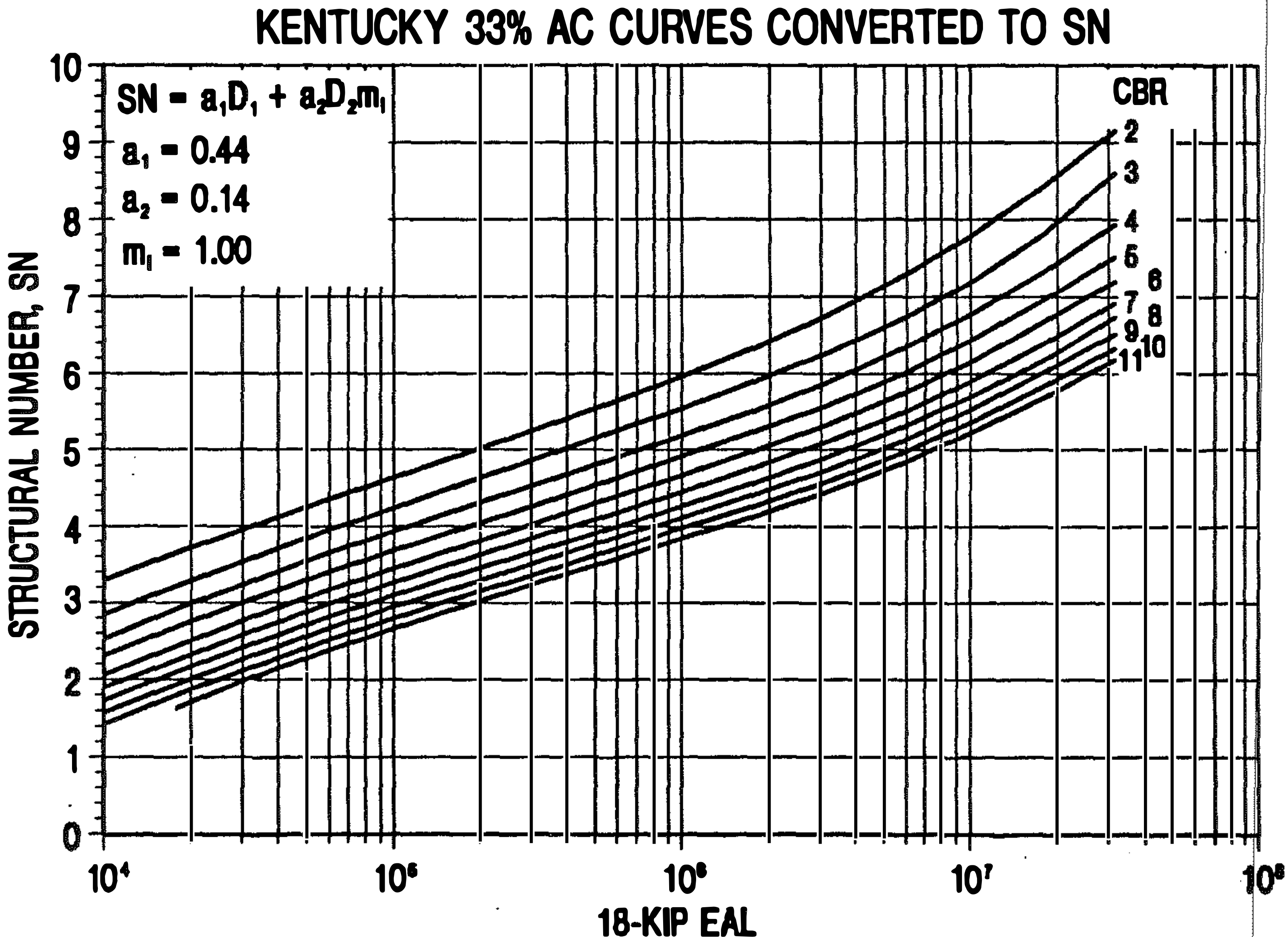


Figure 16. Kentucky Design Thicknesses (Figure 15) Converted to Structural Number.

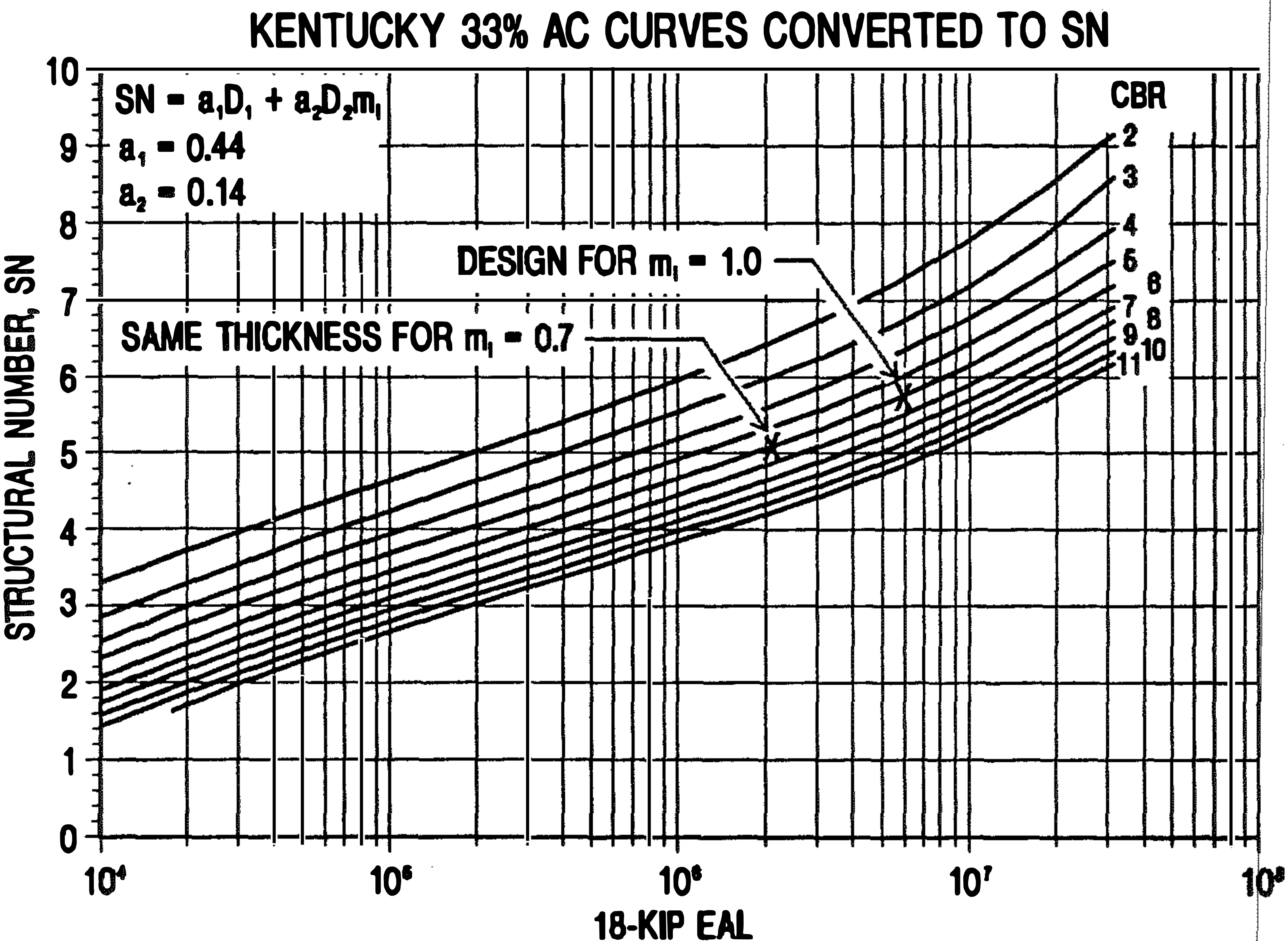


Figure 17. Figure 16 Used to Illustrate the Loss of Design EAL When the Value of m_2 Changes from 1.0 to 0.7.

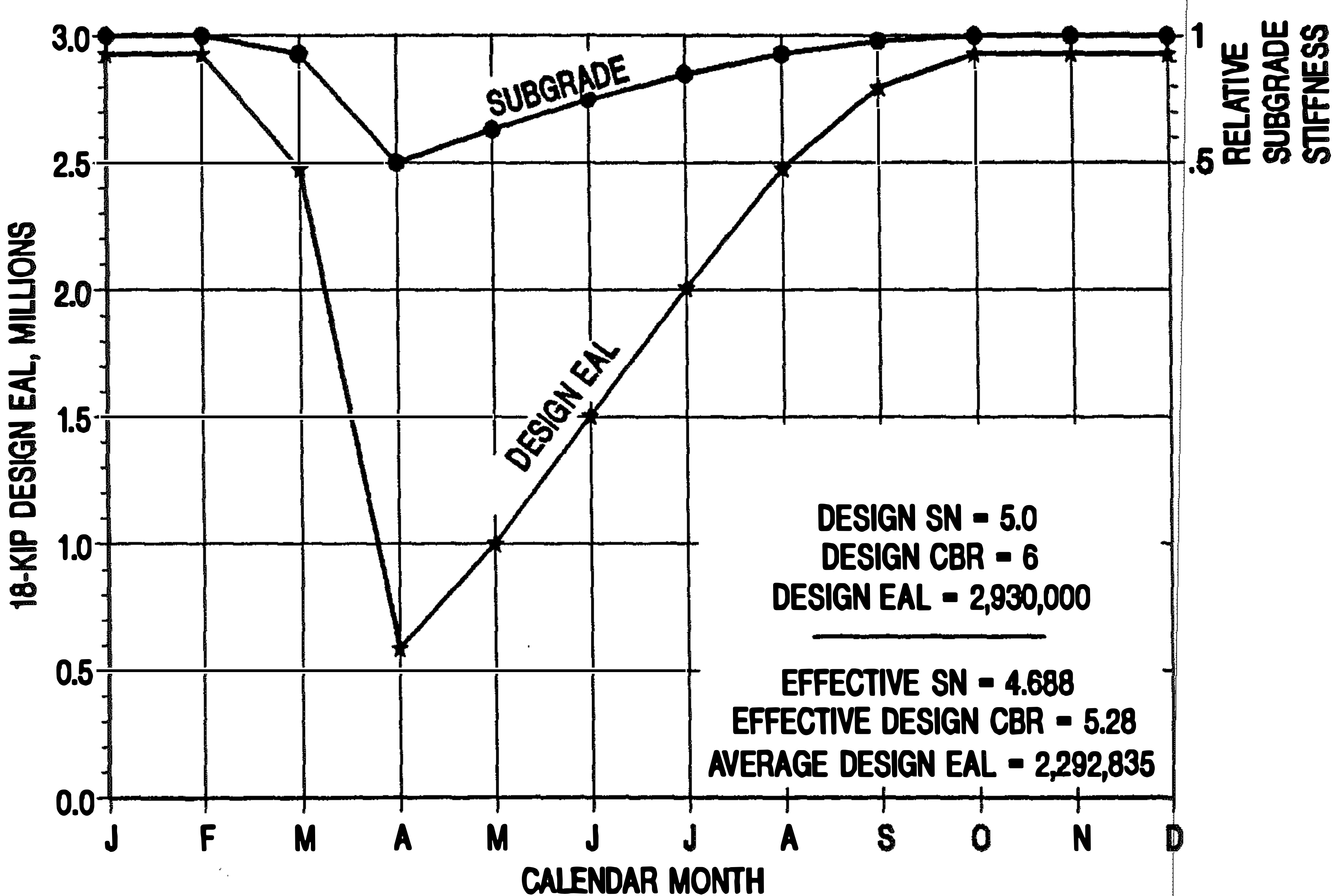


Figure 18. The Change in Design EAL for a SN = 5.0 Due to Relative Change in Subgrade Stiffness as a Function of Calendar Month.

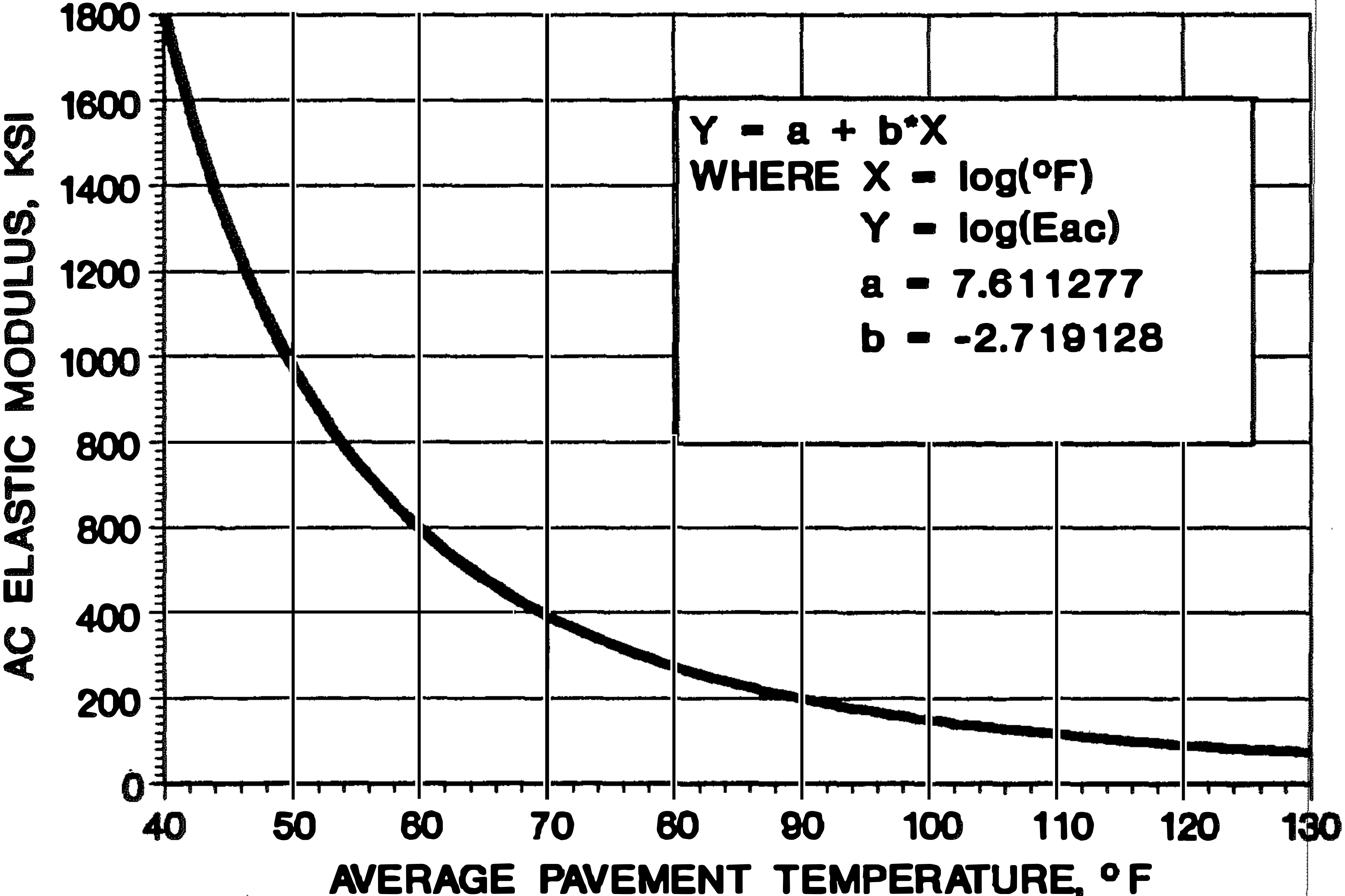


Figure 19. Modulus of Elasticity of Asphaltic Concrete as a Function of Average Pavement Temperature, ^{0}F.

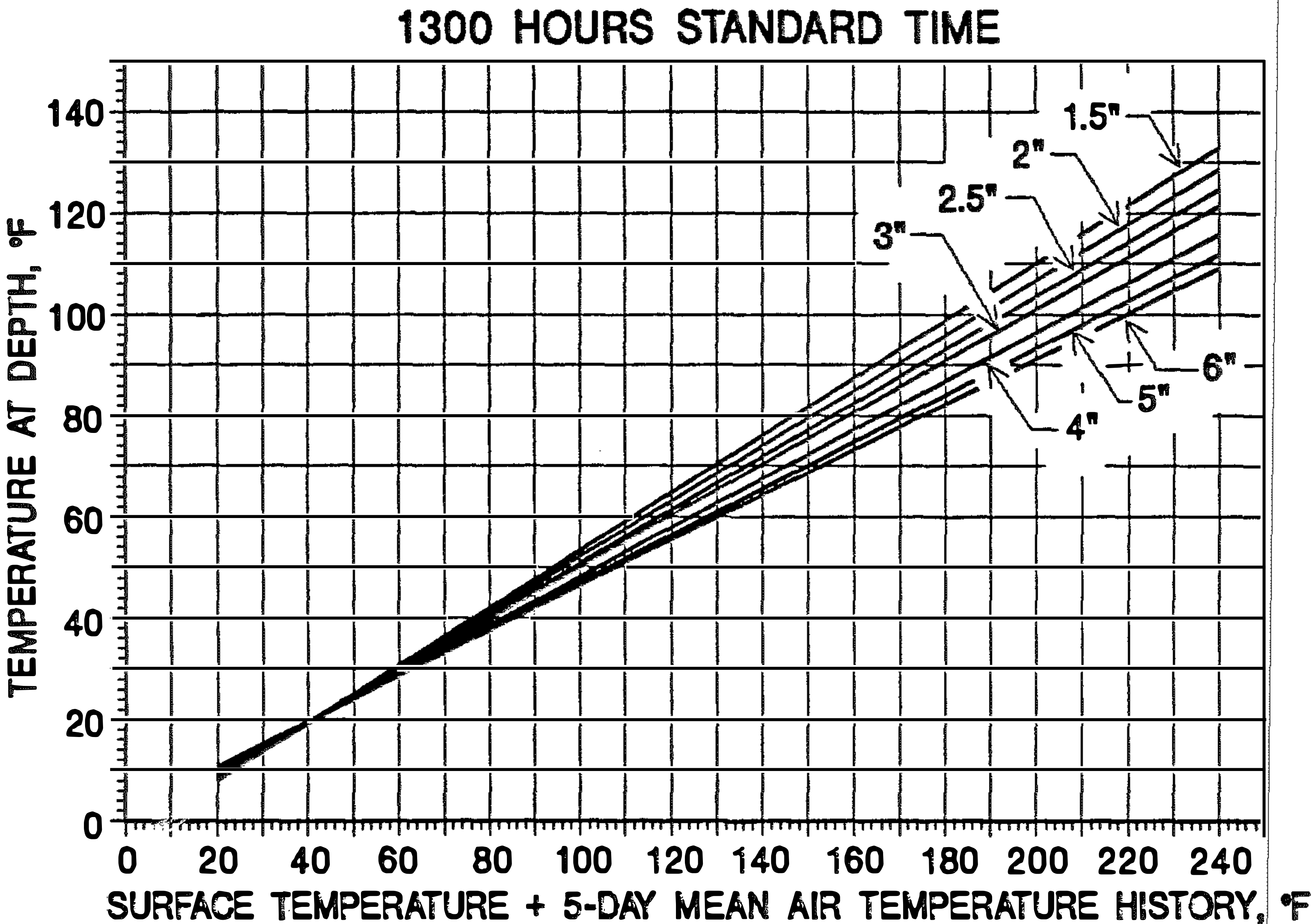


Figure 20. Chart to Estimate Temperature at Depths in Asphaltic Concrete at 1300 Hours Standard Time.

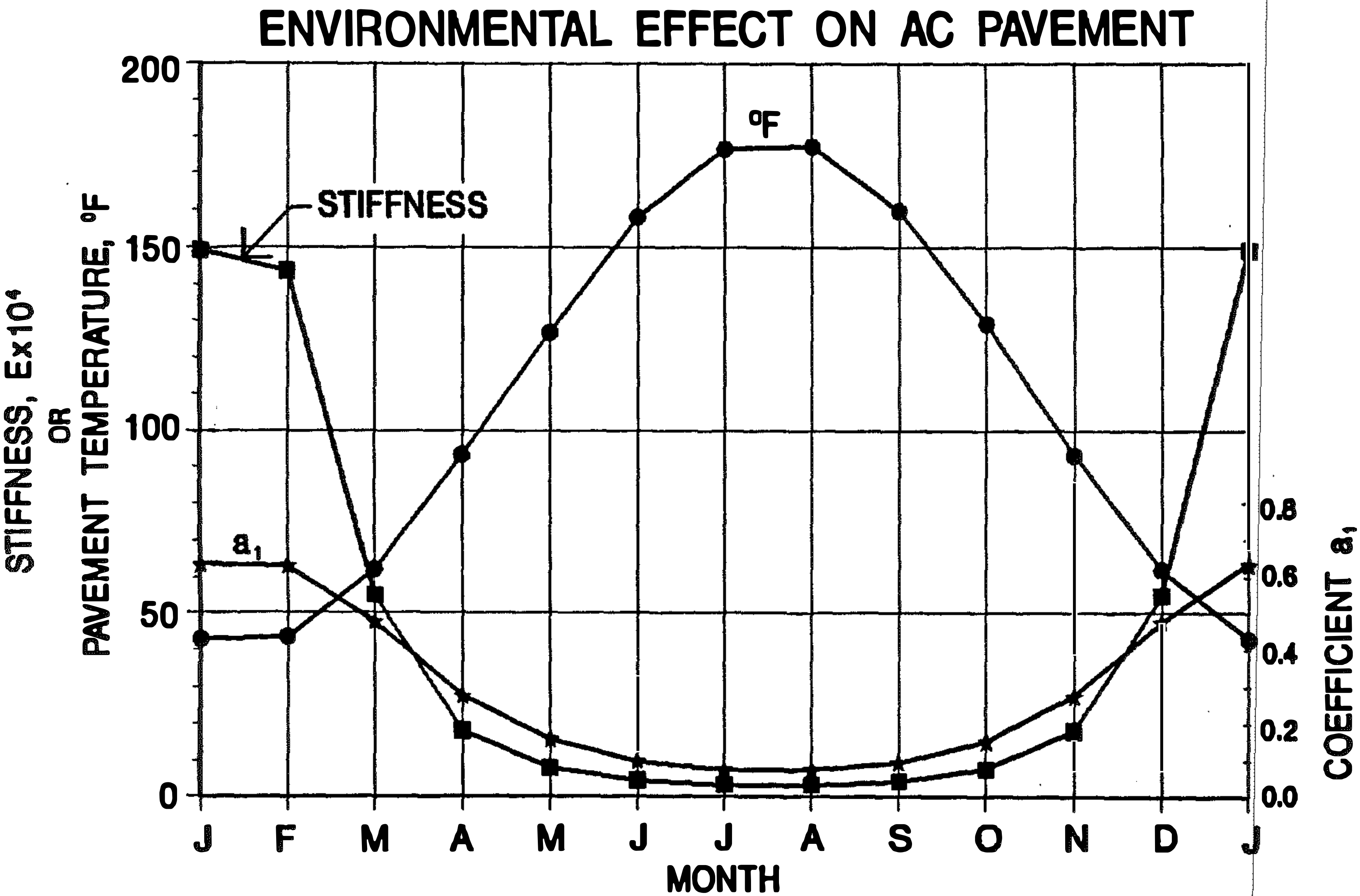


Figure 21. Enviornmental Effects upon Pavement Temperature, Stiffness, and Coefficient a_1 Versus Calendar Month.

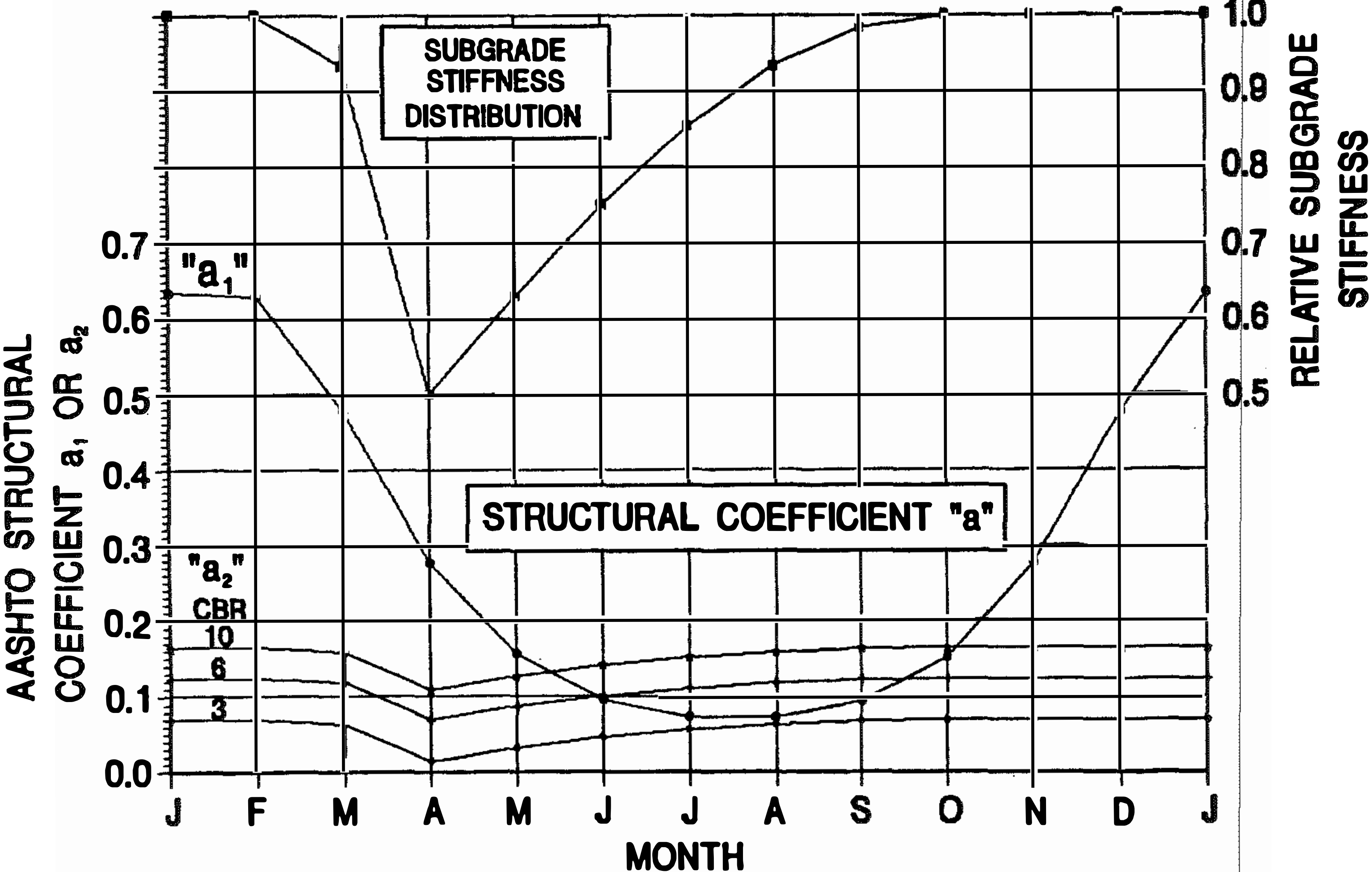


Figure 22. Variation in Coefficient a_1 Due to Pavement Temperature and Coefficient a_2 Due to Change in Subgrade Stiffness as a Function of Calendar Month.

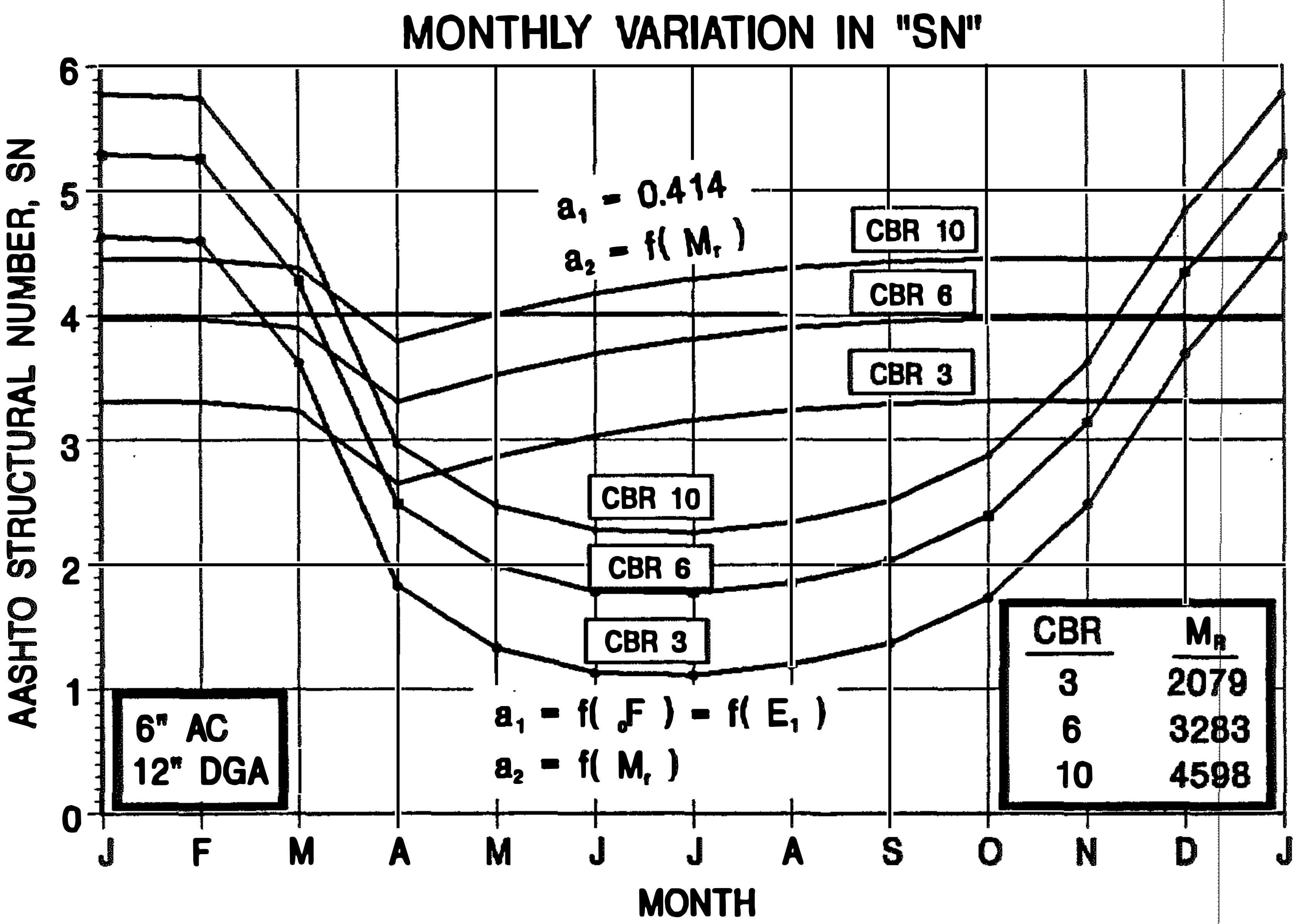


Figure 23. Effects of Environmental Conditions upon Pavement Structures if a_1 Remains Constant, and for Variations in both a_1 and a_2 as a Function of Calendar Month.

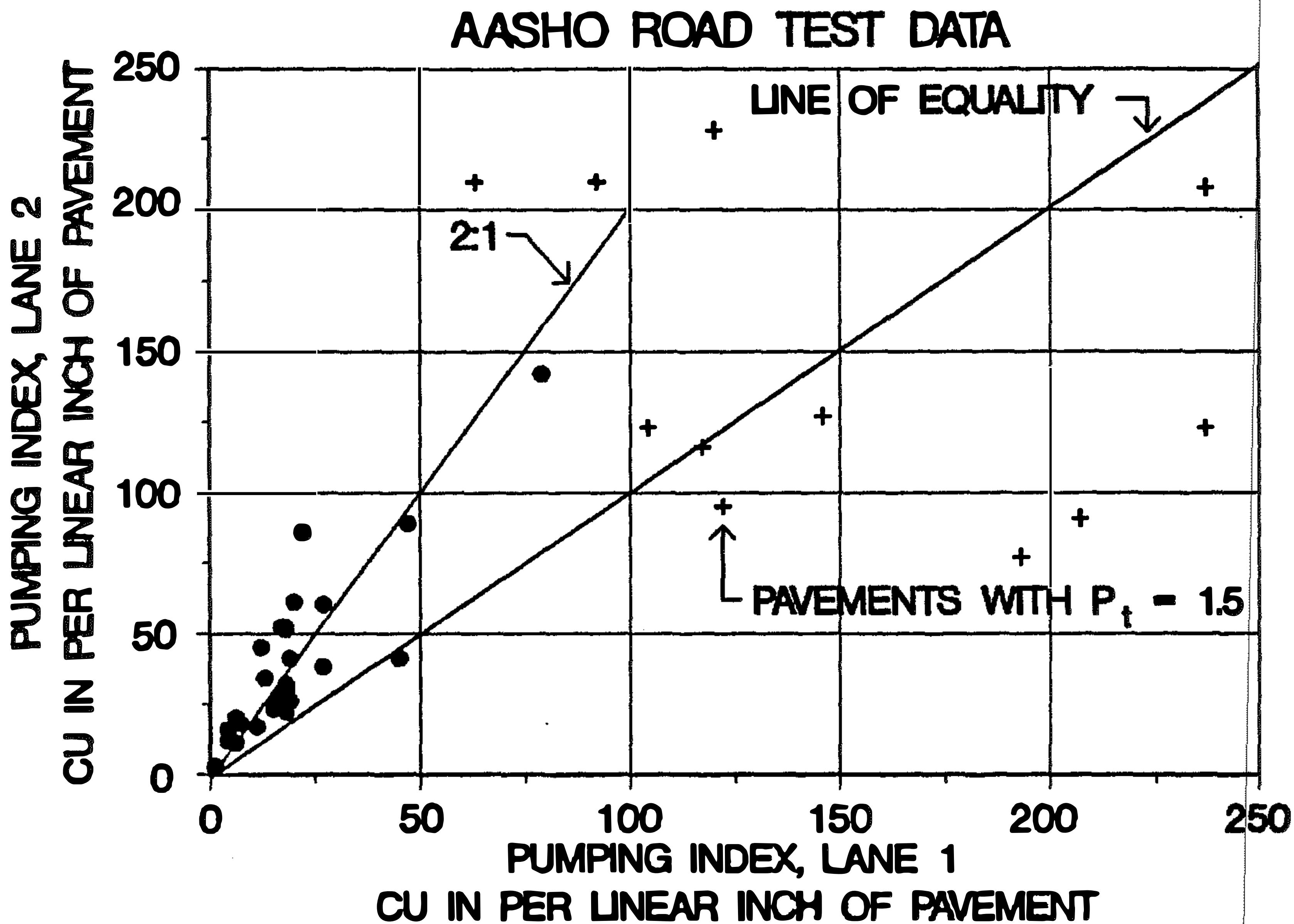


Figure 24. Pumping Index for both Lane 1 and Lane 2 of AASHO Road Test (Table 54 of Reference 1).

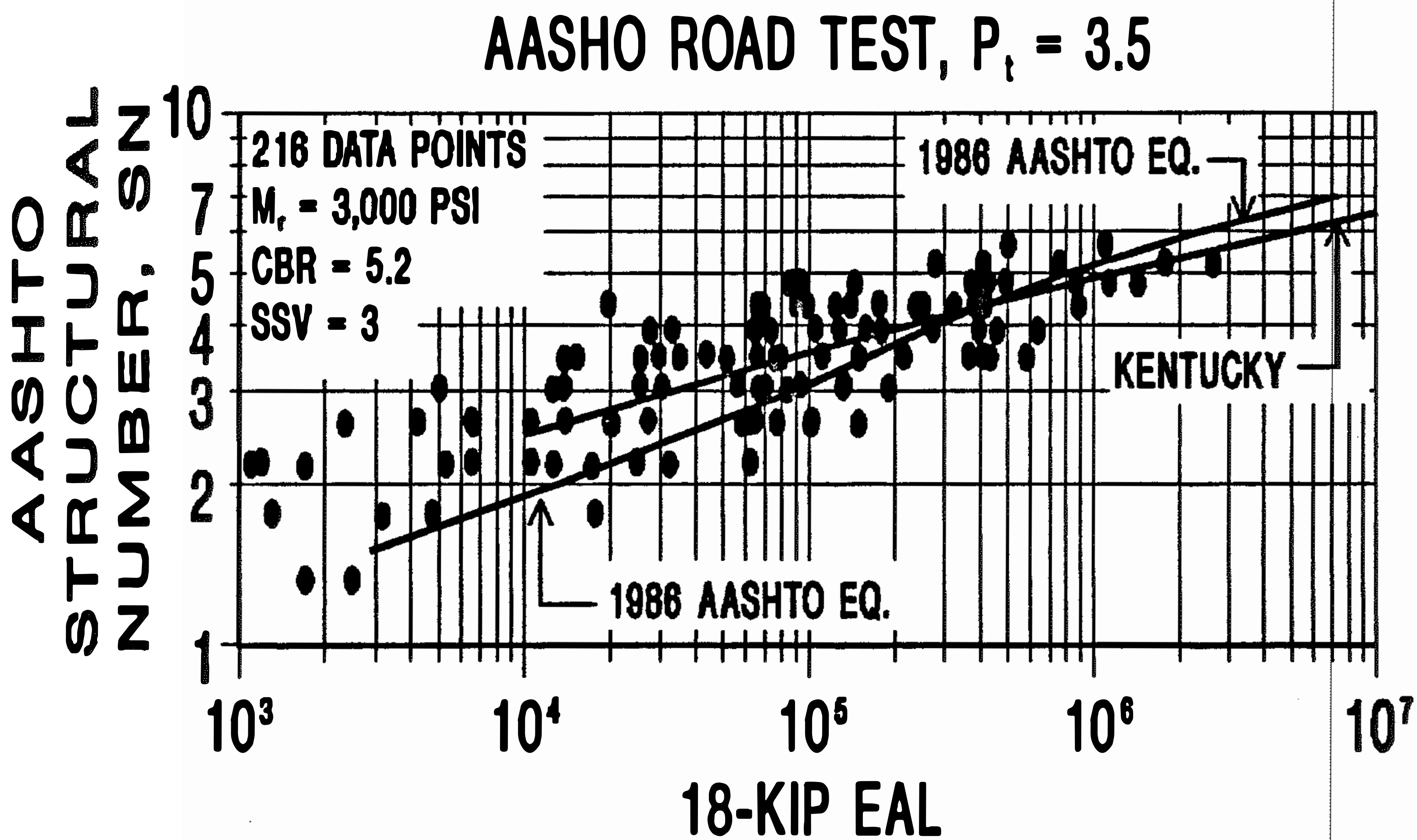


Figure 25. Fatigue Data From AASHO Road Test for P_t = 3.5 (Appendix A, Reference 1) with Kentucky and AASHTO Design Curves Superimposed.

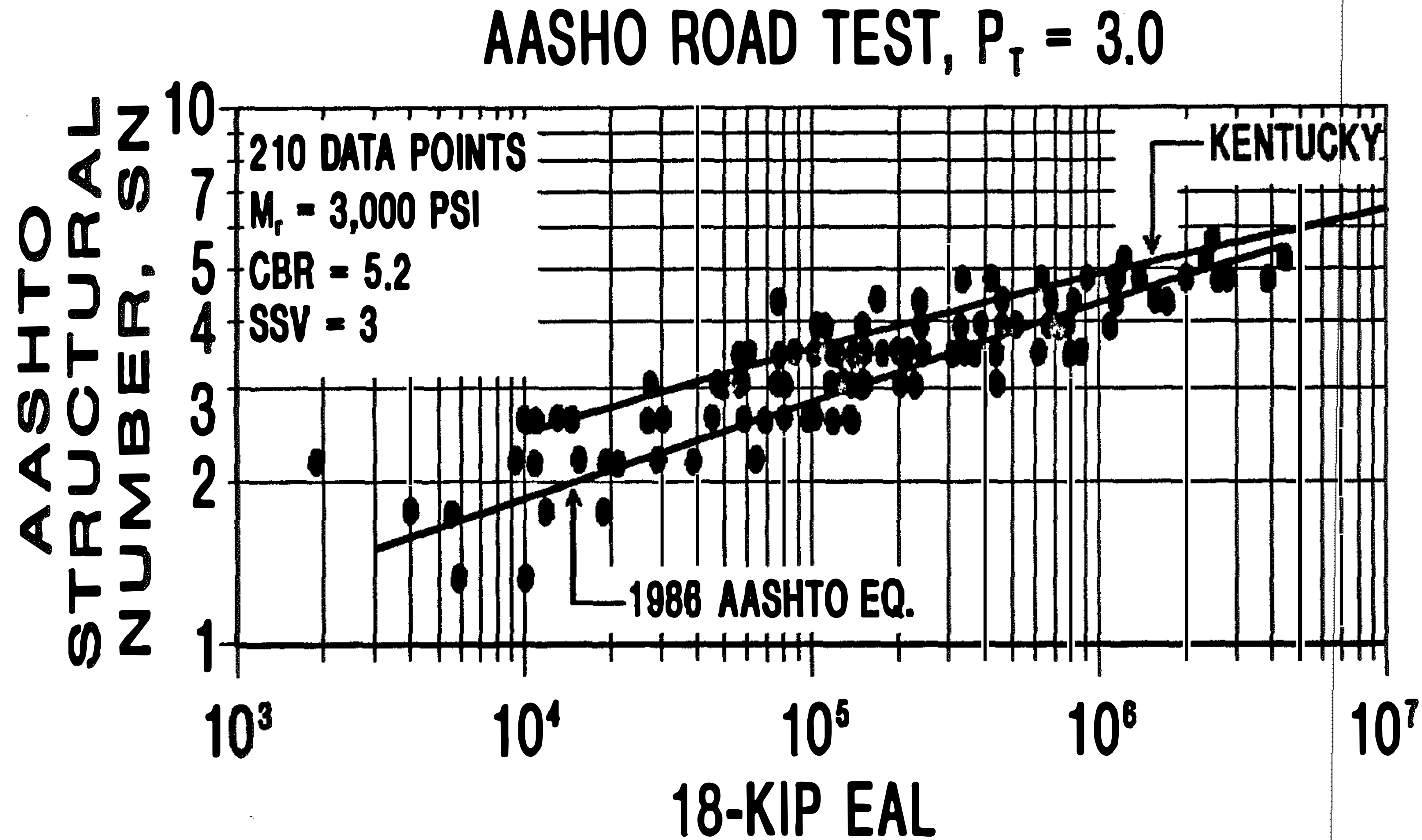


Figure 26. Fatigue Data From AASHO Road Test for P_t = 3.0 (Appendix A, Reference 1) with Kentucky and AASHTO Design Curves Superimposed.

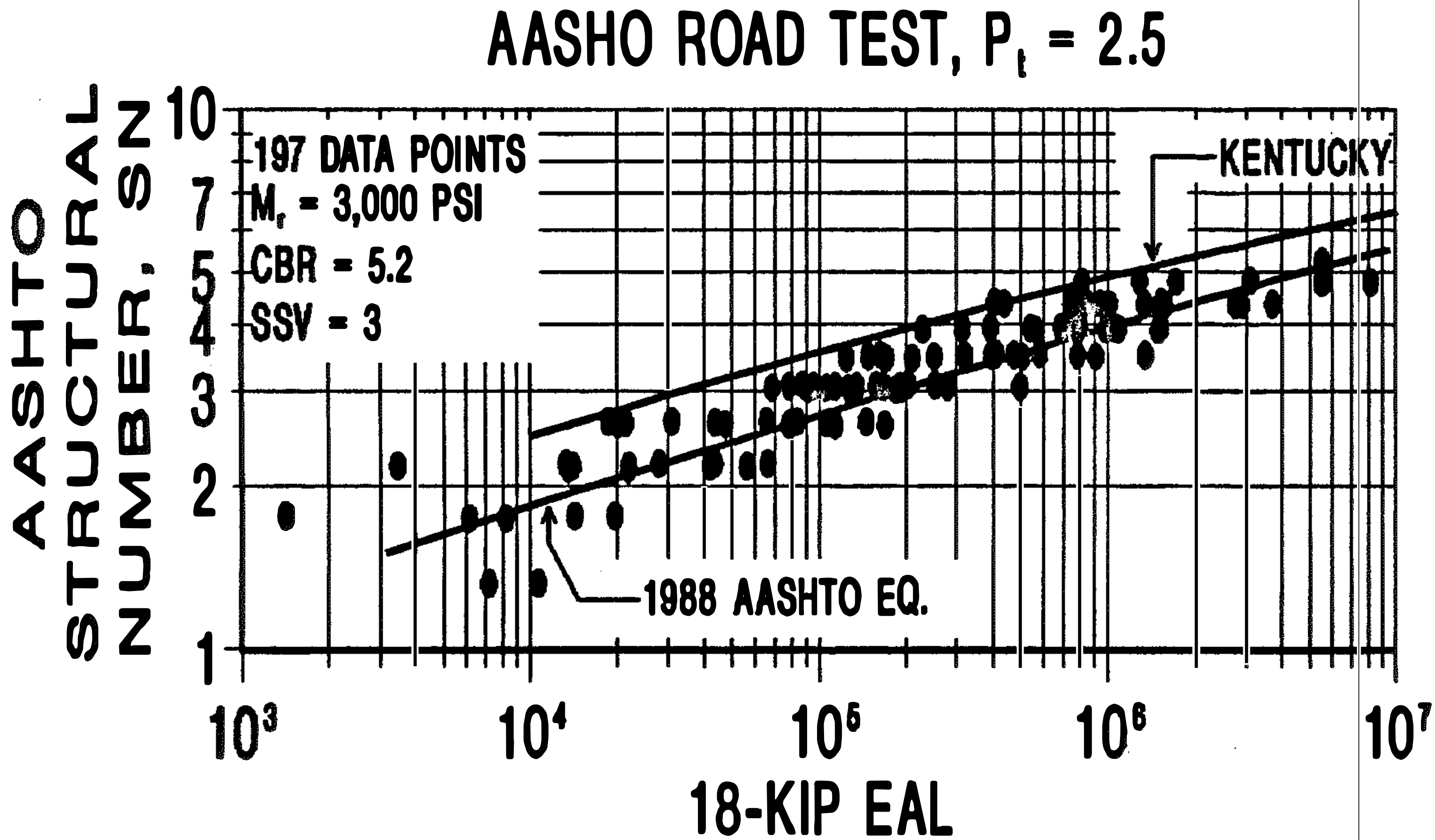


Figure 27. Fatigue Data From AASHO Road Test for P_t = 2.5 (Appendix A, Reference 1) with Kentucky and AASHTO Design Curves Superimposed.

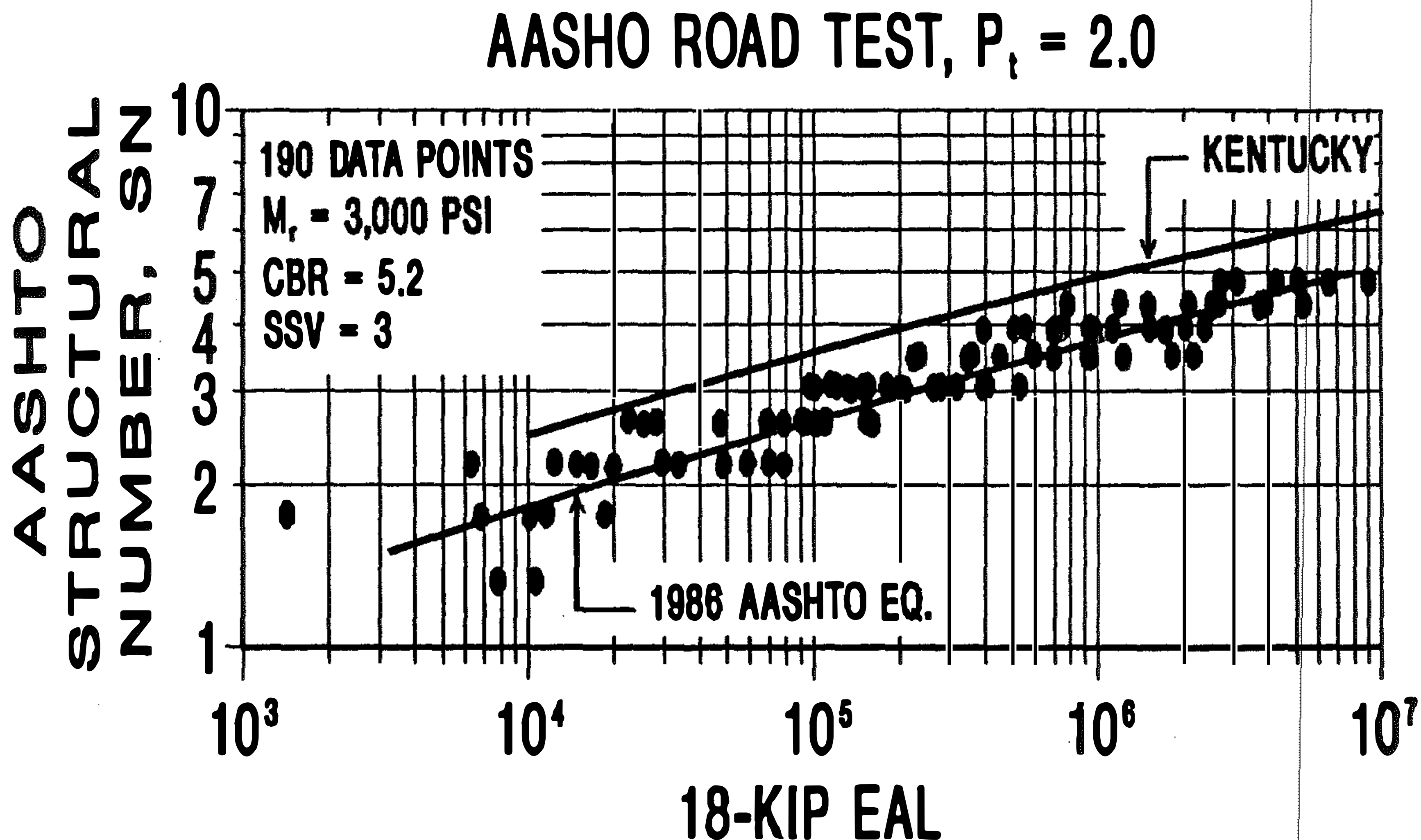


Figure 28. Fatigue Data From AASHO Road Test for P_t = 2.0 (Appendix A, Reference 1) with Kentucky and AASHTO Design Curves Superimposed.

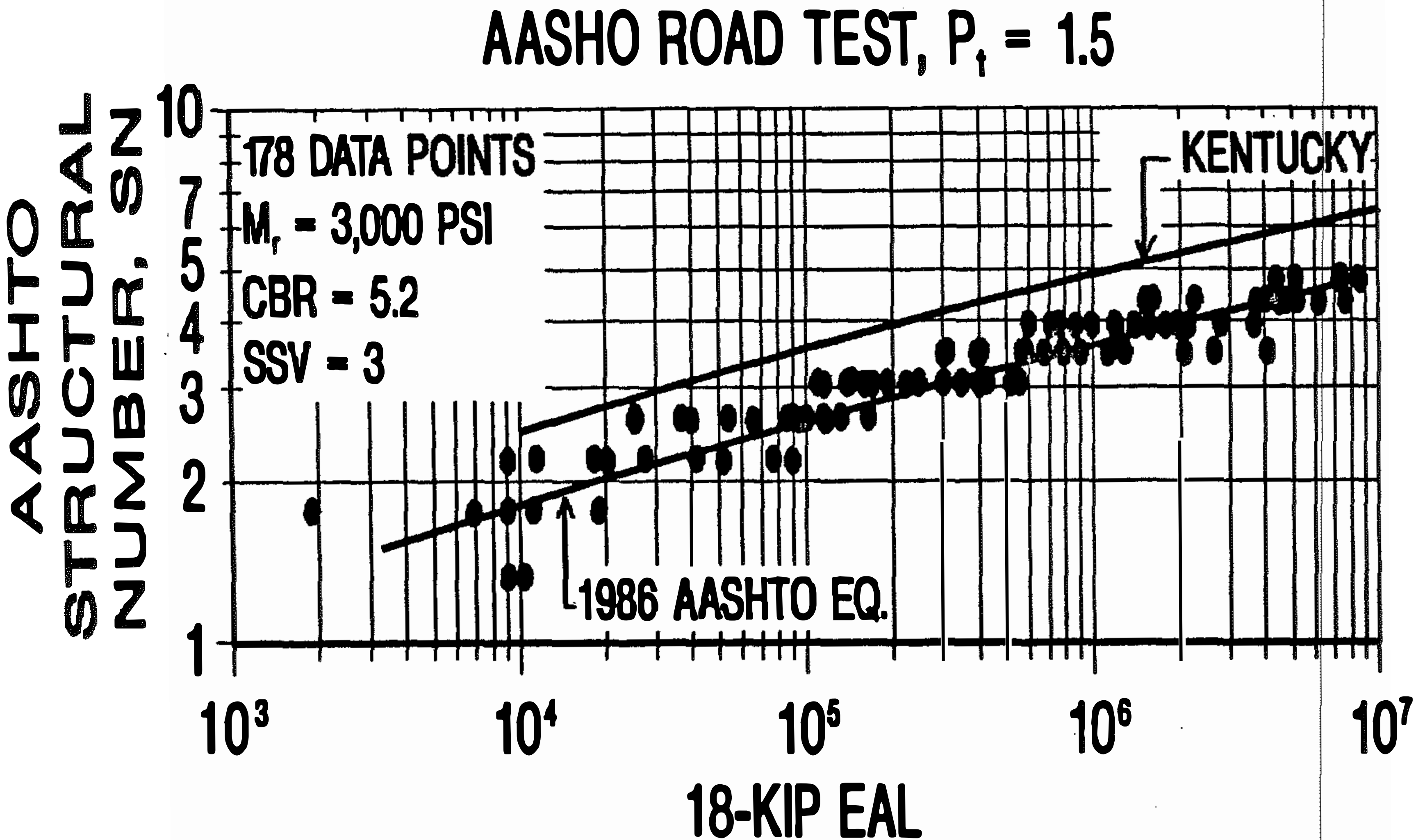


Figure 29. Fatigue Data From AASHO Road Test for P_t = 1.5 (Appendix A, Reference 1) with Kentucky and AASHTO Design Curves Superimposed.

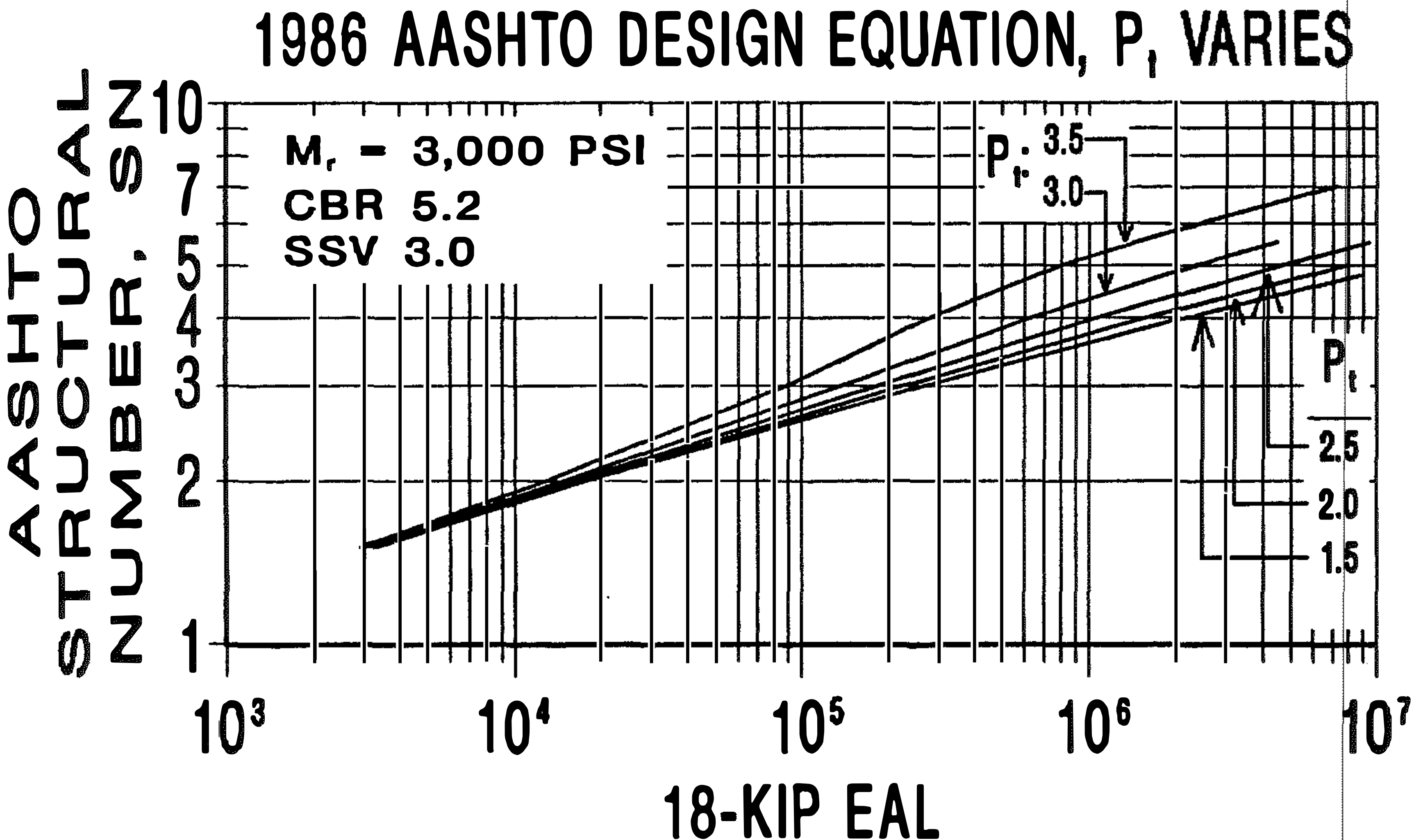


Figure 30. AASHTO Fatigue Equation Solved for Five Levels of Serviceability.

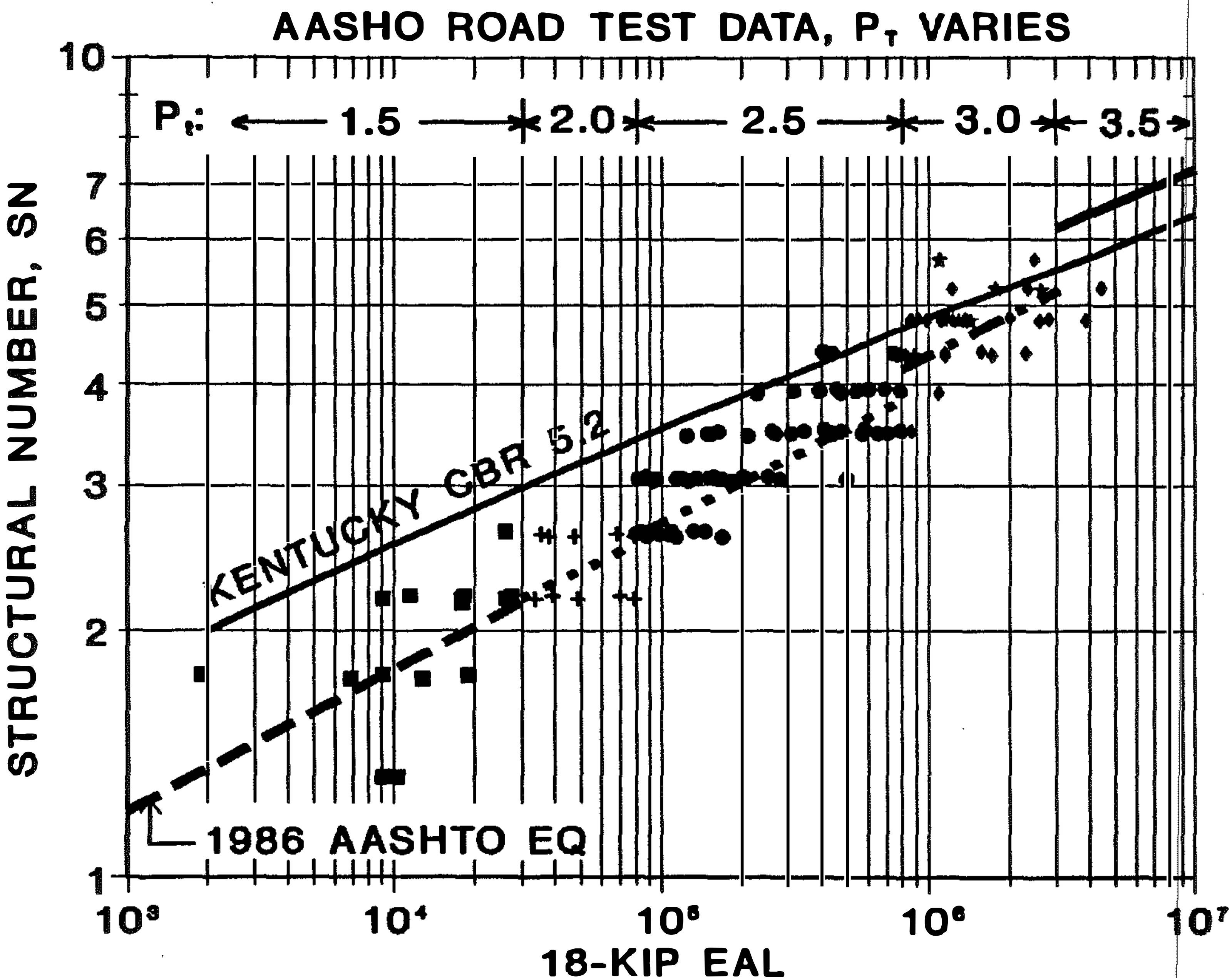
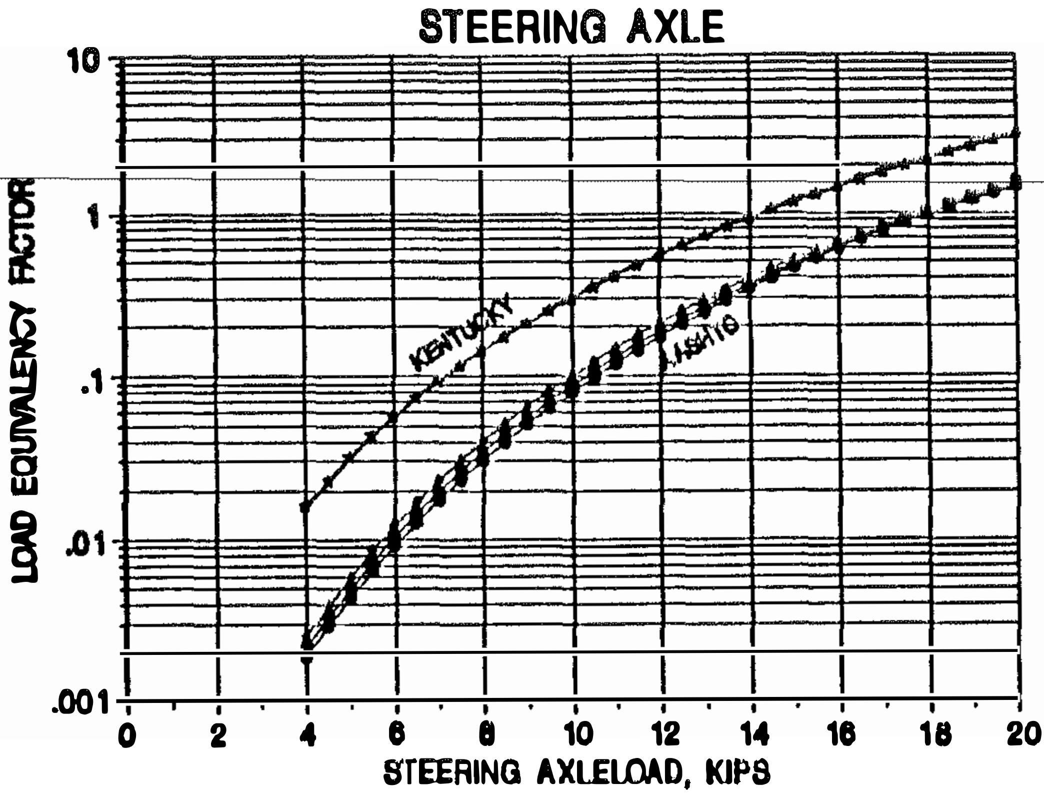


Figure 31. AASHO Road Test Data from Sections of Figures 25-29 to Illustrate that the Kentucky Design Curve Conforms to a Variable Level of Serviceability.



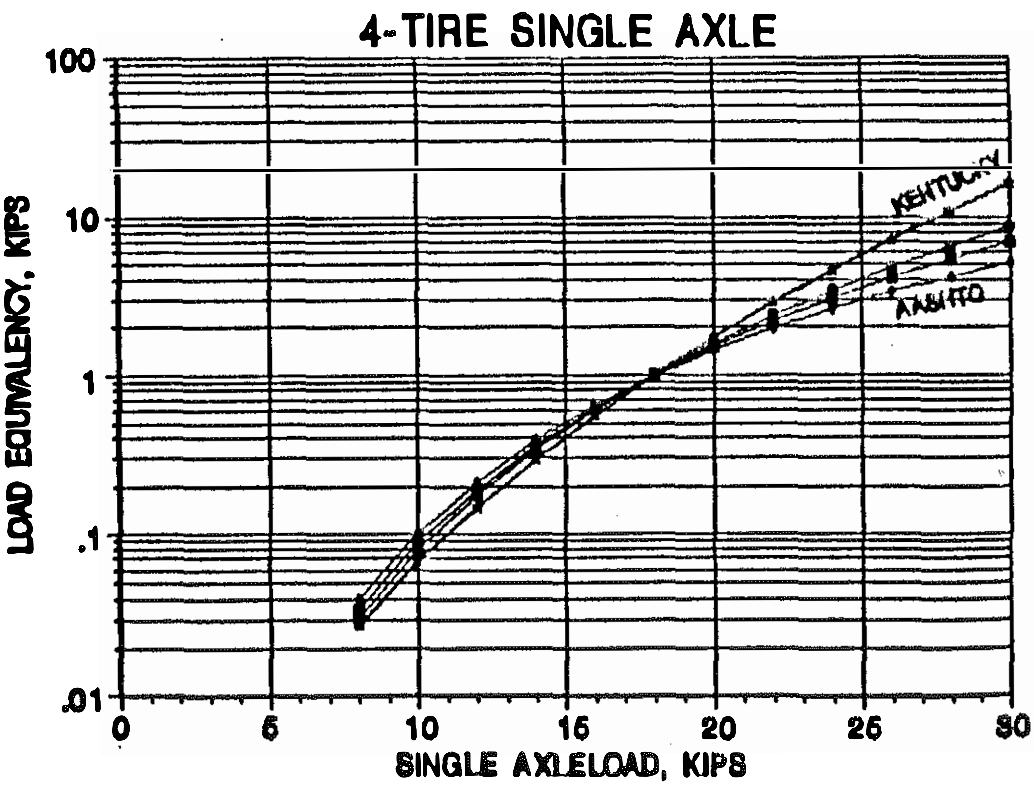
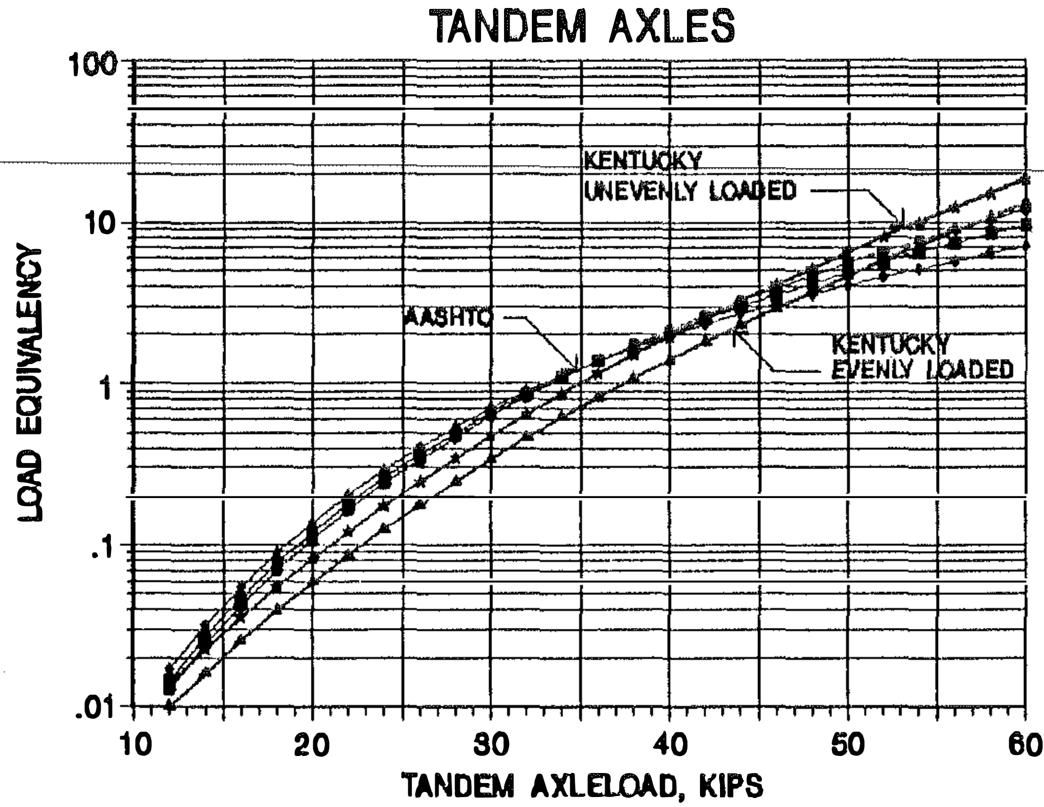


Figure 32. Comparisons of Kentucky and AASHTO Load Equivalency Relationships for Steering and Four-Tired Single Axles.



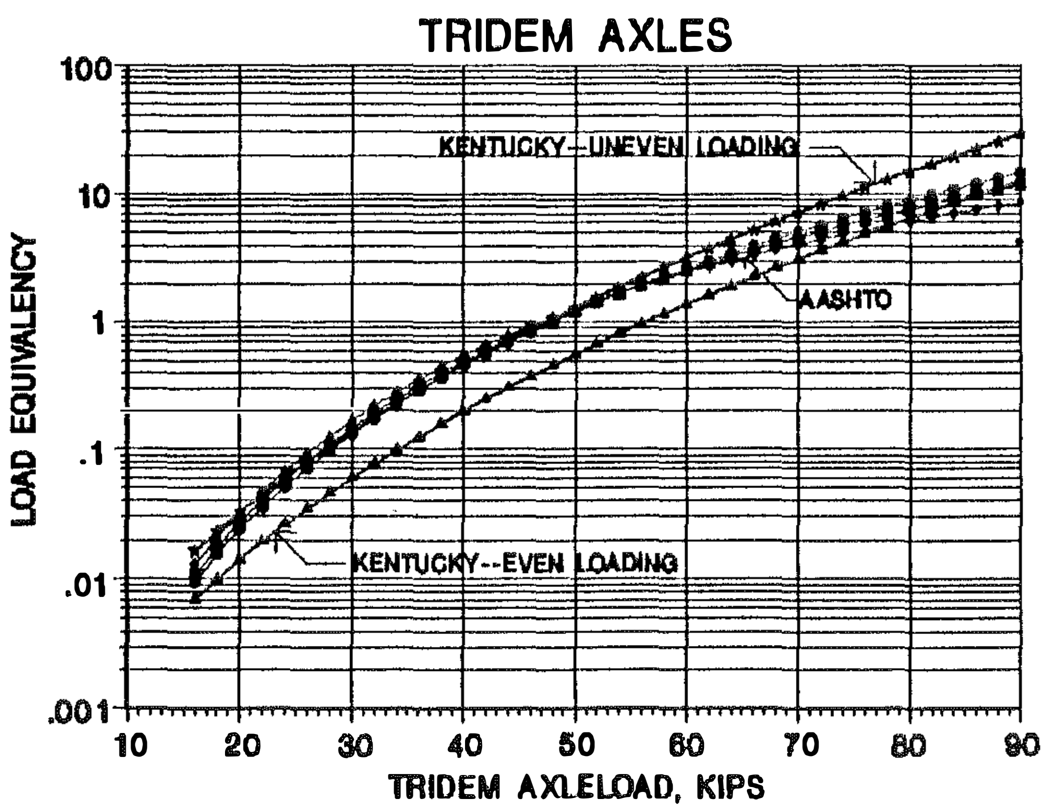


Figure 33. Comparisons of Kentucky and AASHTO Load Equivalency Relationships for Tandem and Tridem Axle Groups.

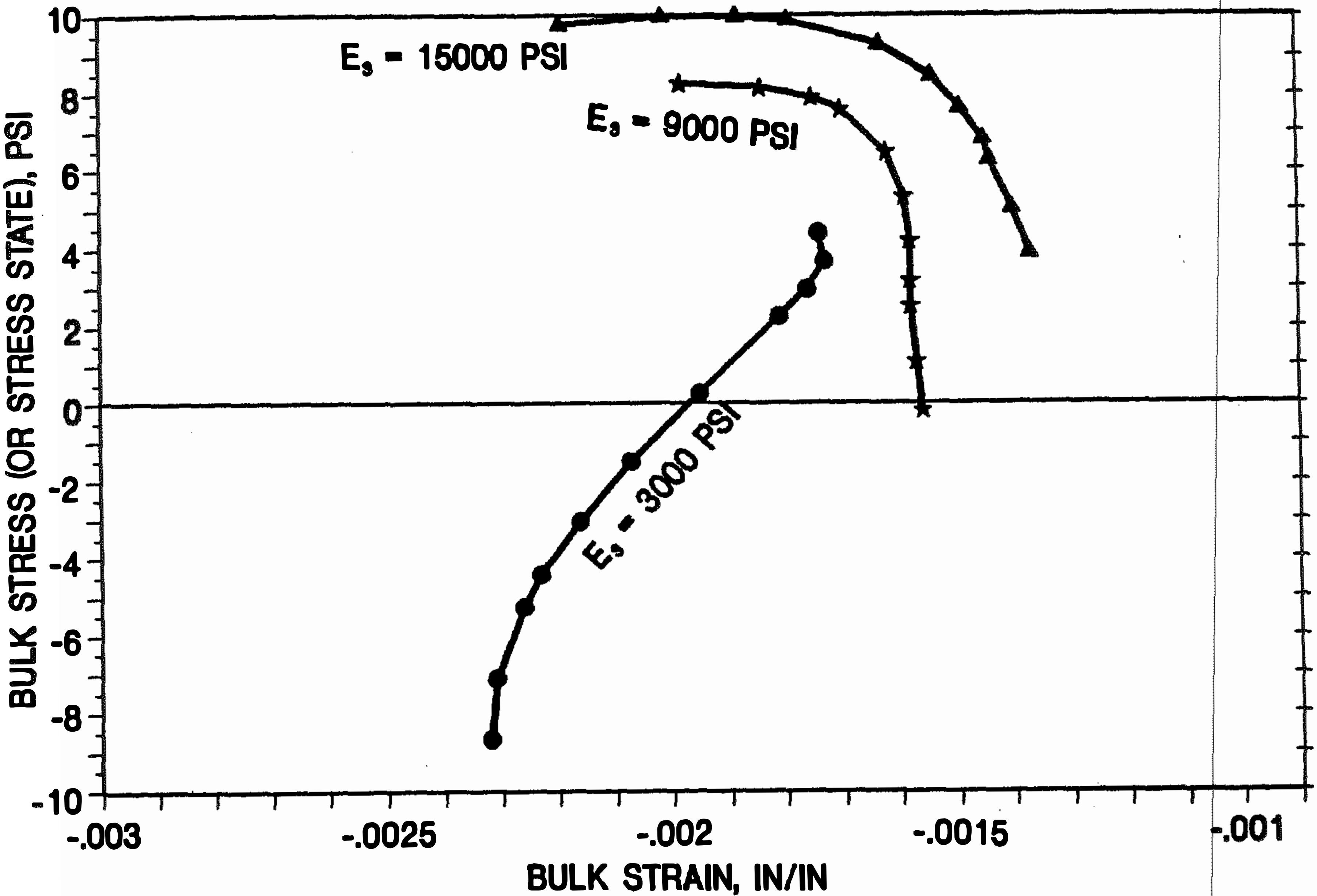


Figure 34. Comparison of Bulk Strain to Bulk Stress for Various Combinations of Base and Subgrade Moduli.

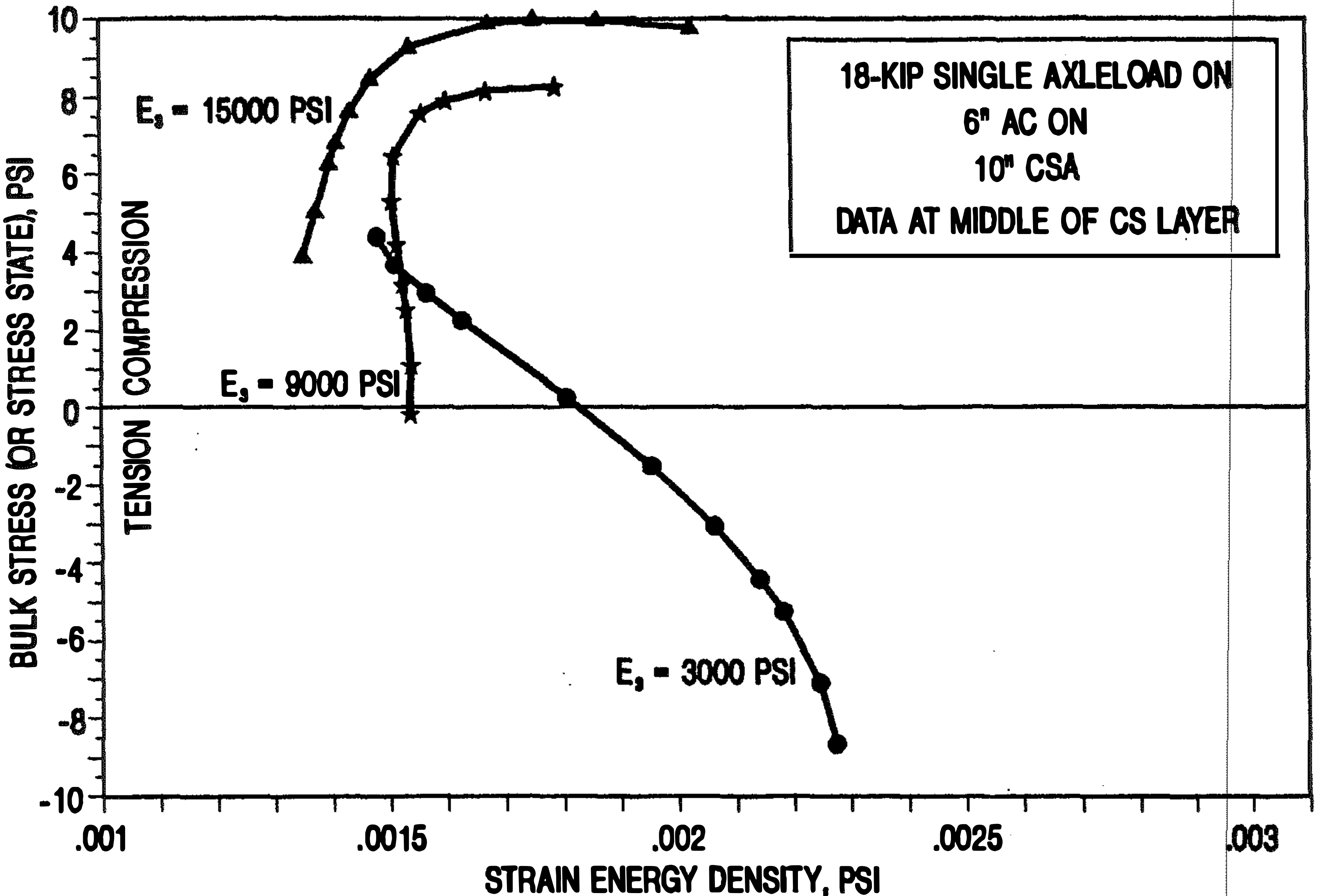


Figure 35. Comparison of Strain Energy Density to Bulk Stress for Various Combinations of Base and Subgrade Moduli.

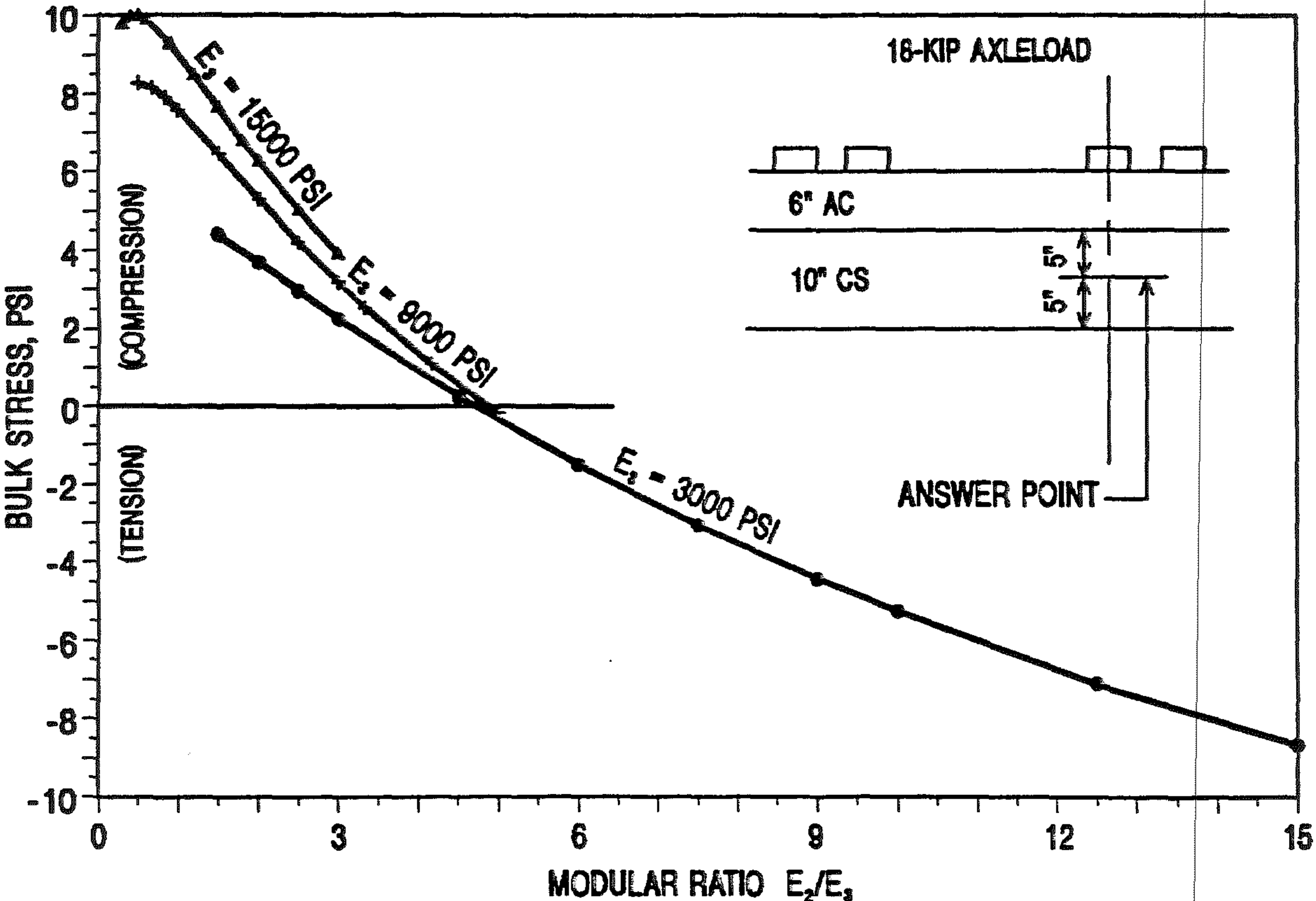


Figure 36. Comparison of Modular Ratio to Bulk Stress for Various Combinations of Base and Subgrade Moduli.

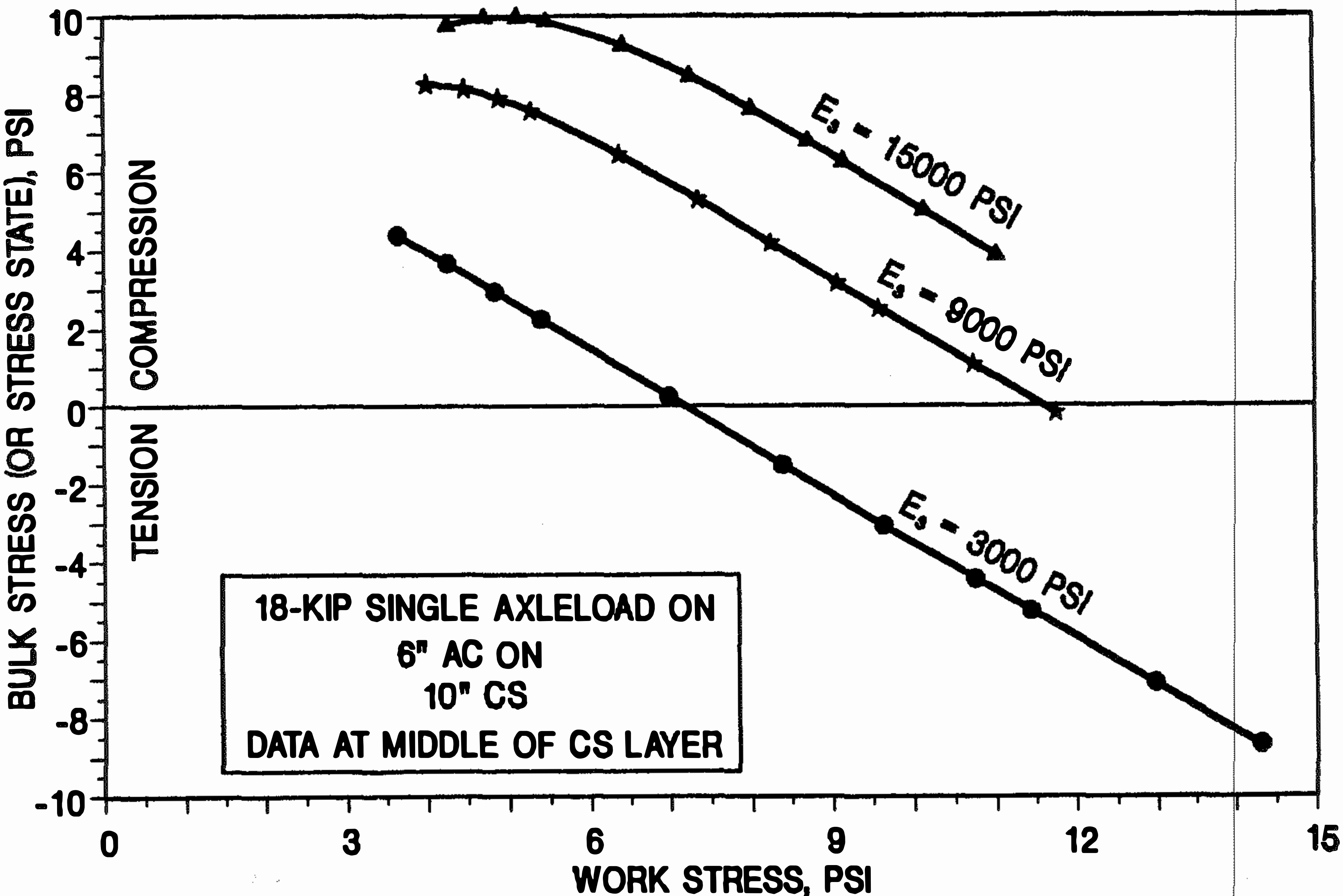


Figure 37. Comparison of Work Stress to Bulk Stress for Various Combinations of Base and Subgrade Moduli.

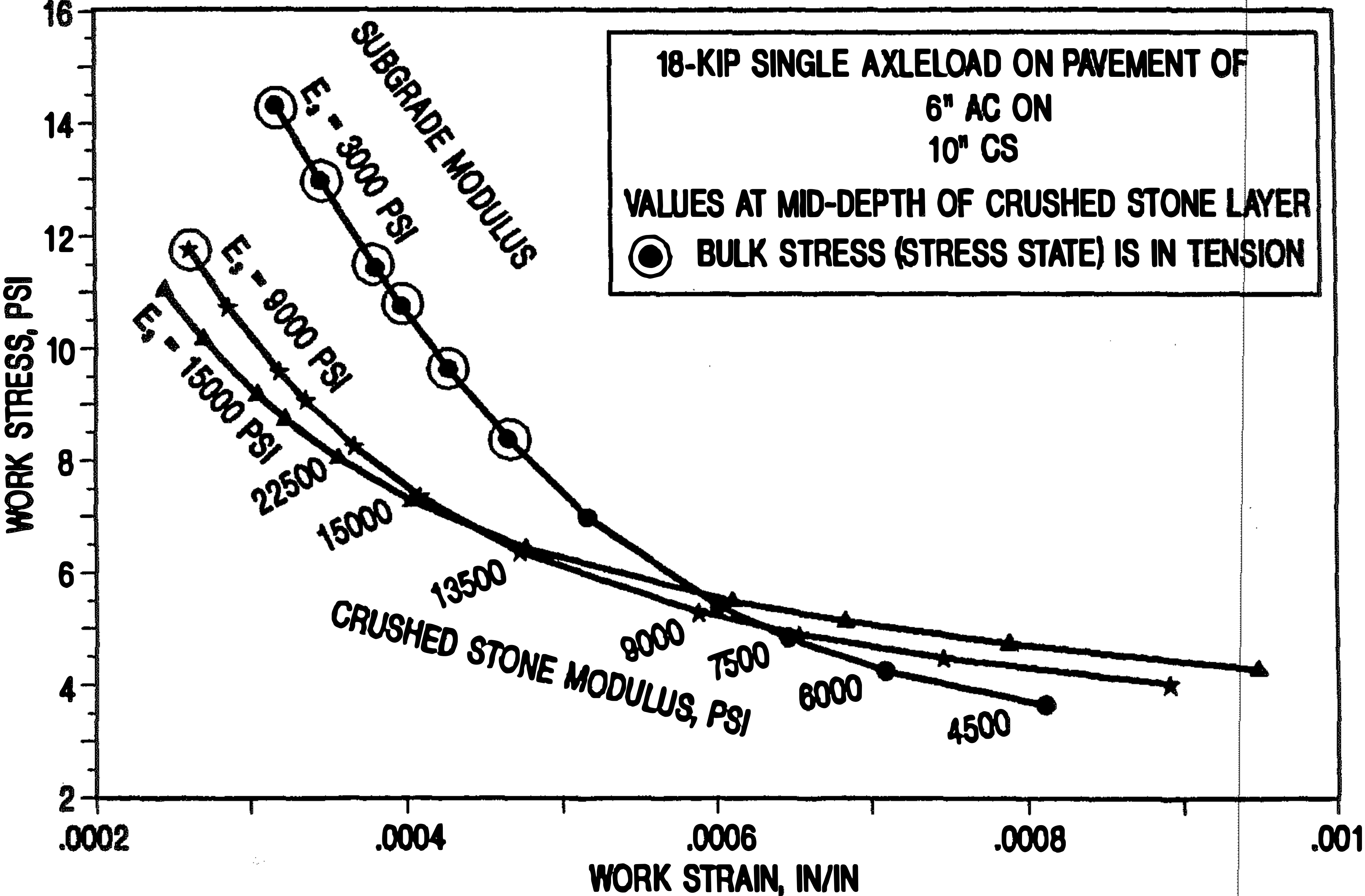


Figure 38. Comparison of Work Strain to Work Stress for Various Combinations of Base and Subgrade Moduli.

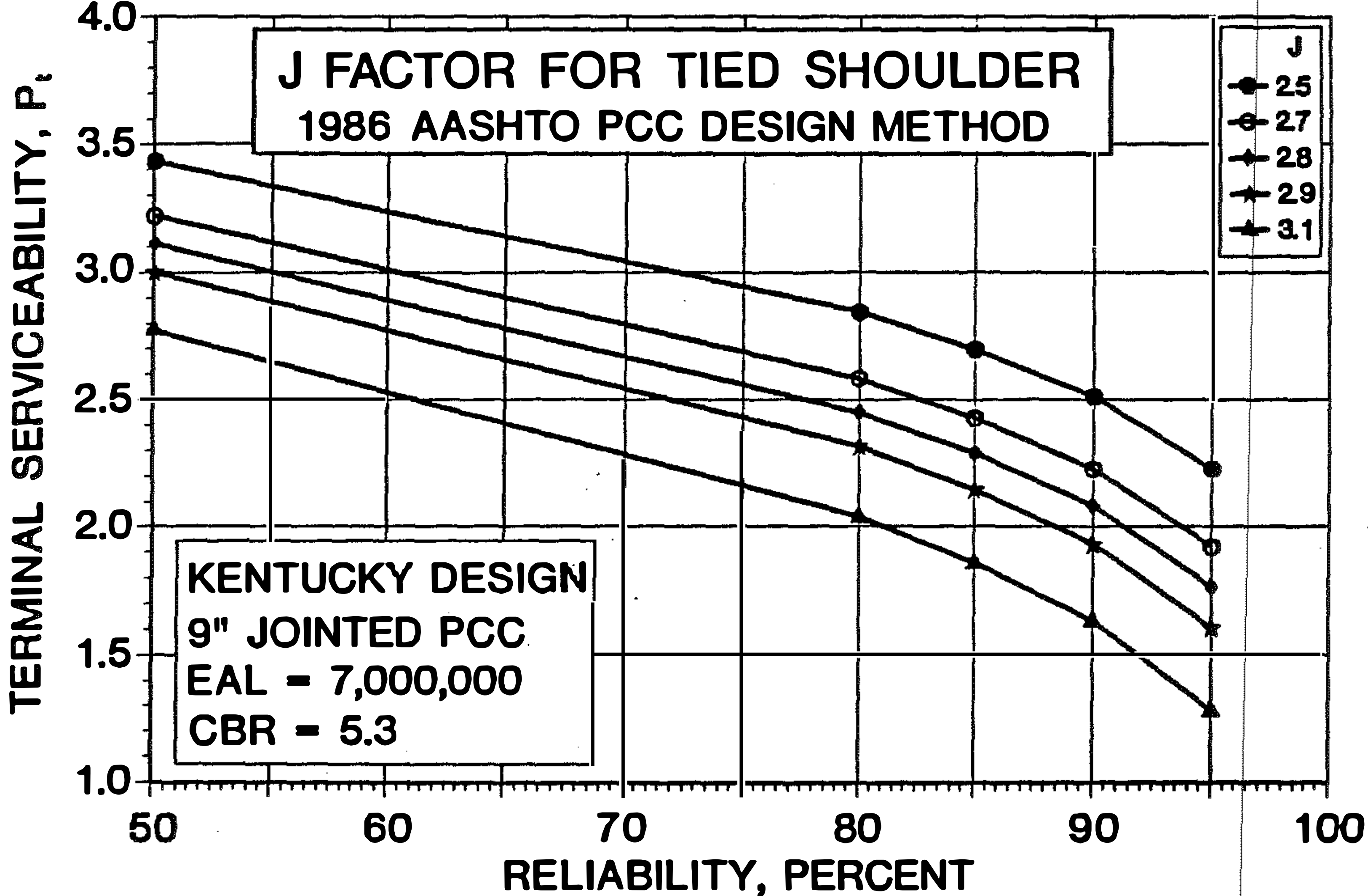


Figure 39. Relationship between Percent Reliability, Terminal Serviceability, and J Factor for Tied Shoulder for 9" Jointed PCC.

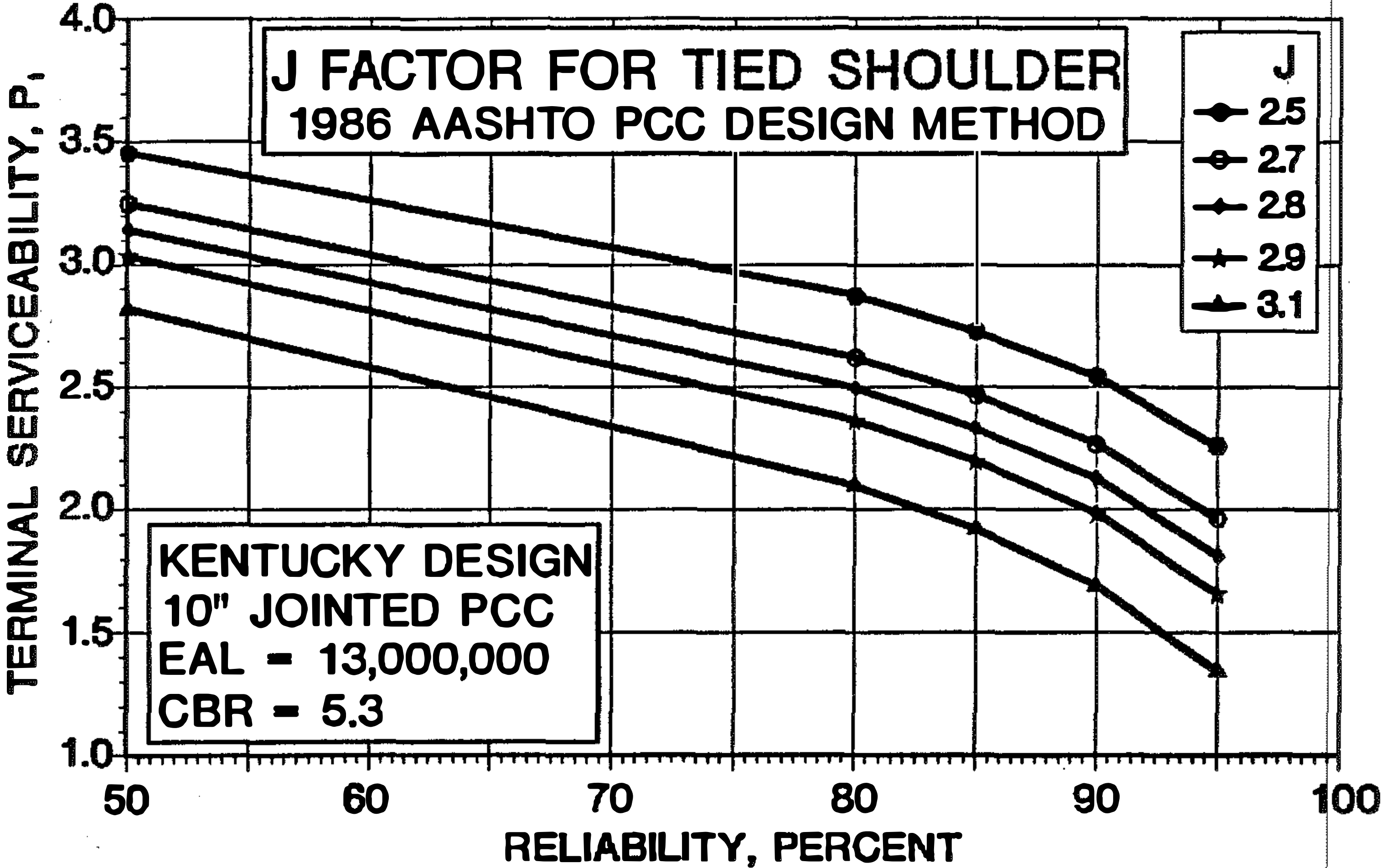


Figure 40. Relationship between Percent Reliability, Terminal Serviceability, and J Factor for Tied Shoulder for 10" Jointed PCC.

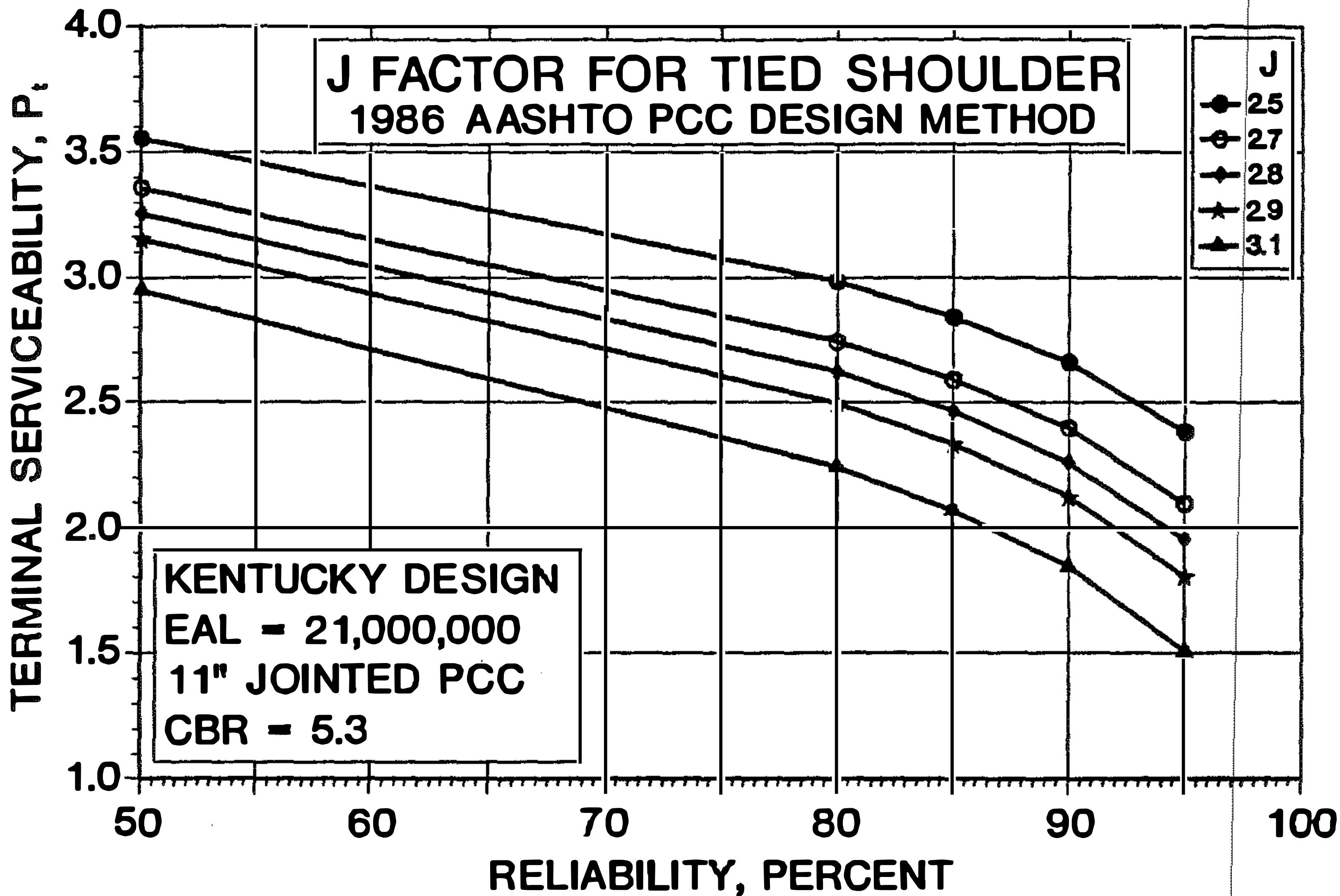


Figure 41. Relationship between Percent Reliability, Terminal Serviceability, and J Factor for Tied Shoulder for 11" Jointed PCC.

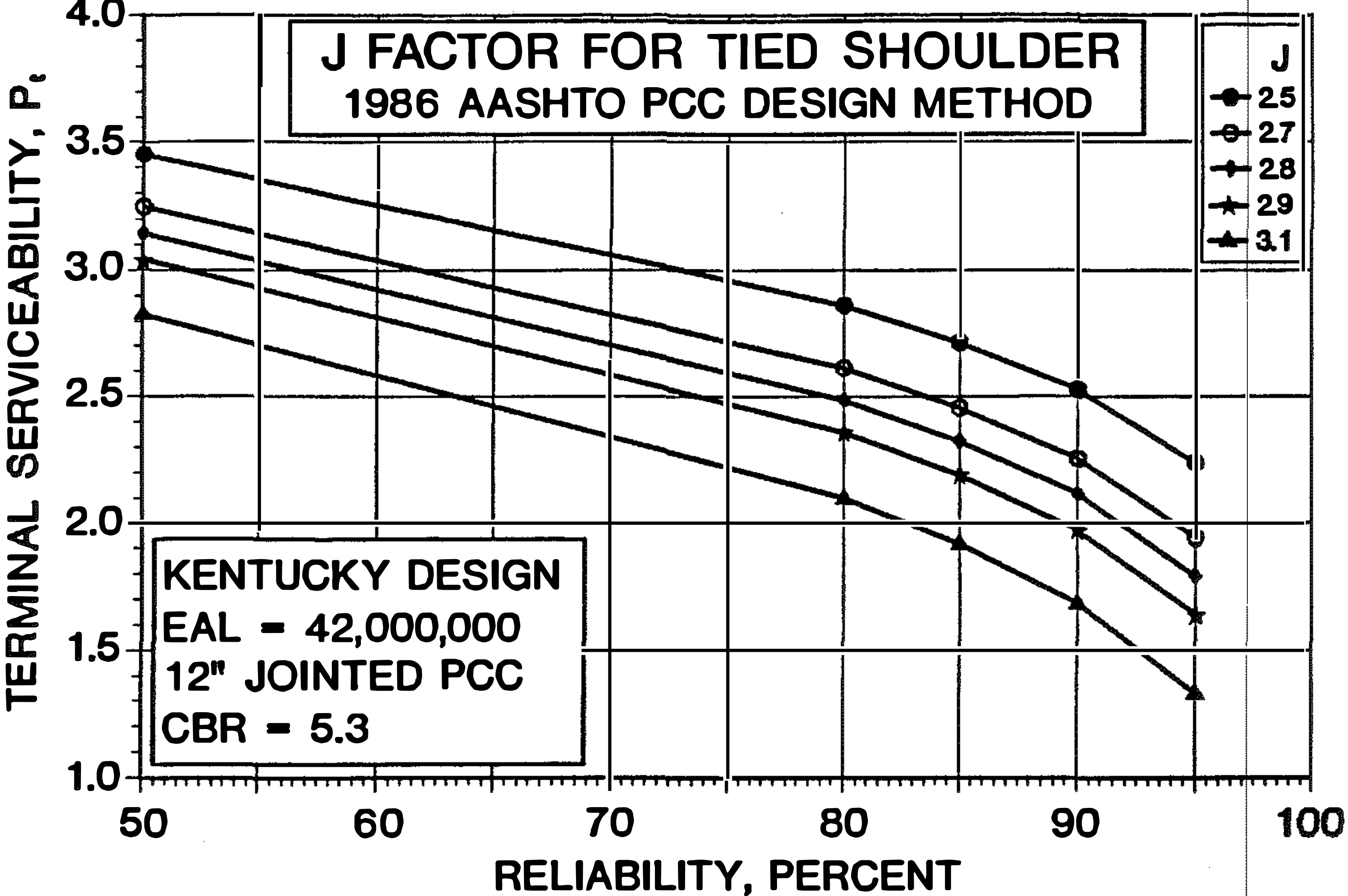


Figure 42. Relationship between Percent Reliability, Terminal Serviceability, and J Factor for Tied Shoulder for 12" Jointed PCC.

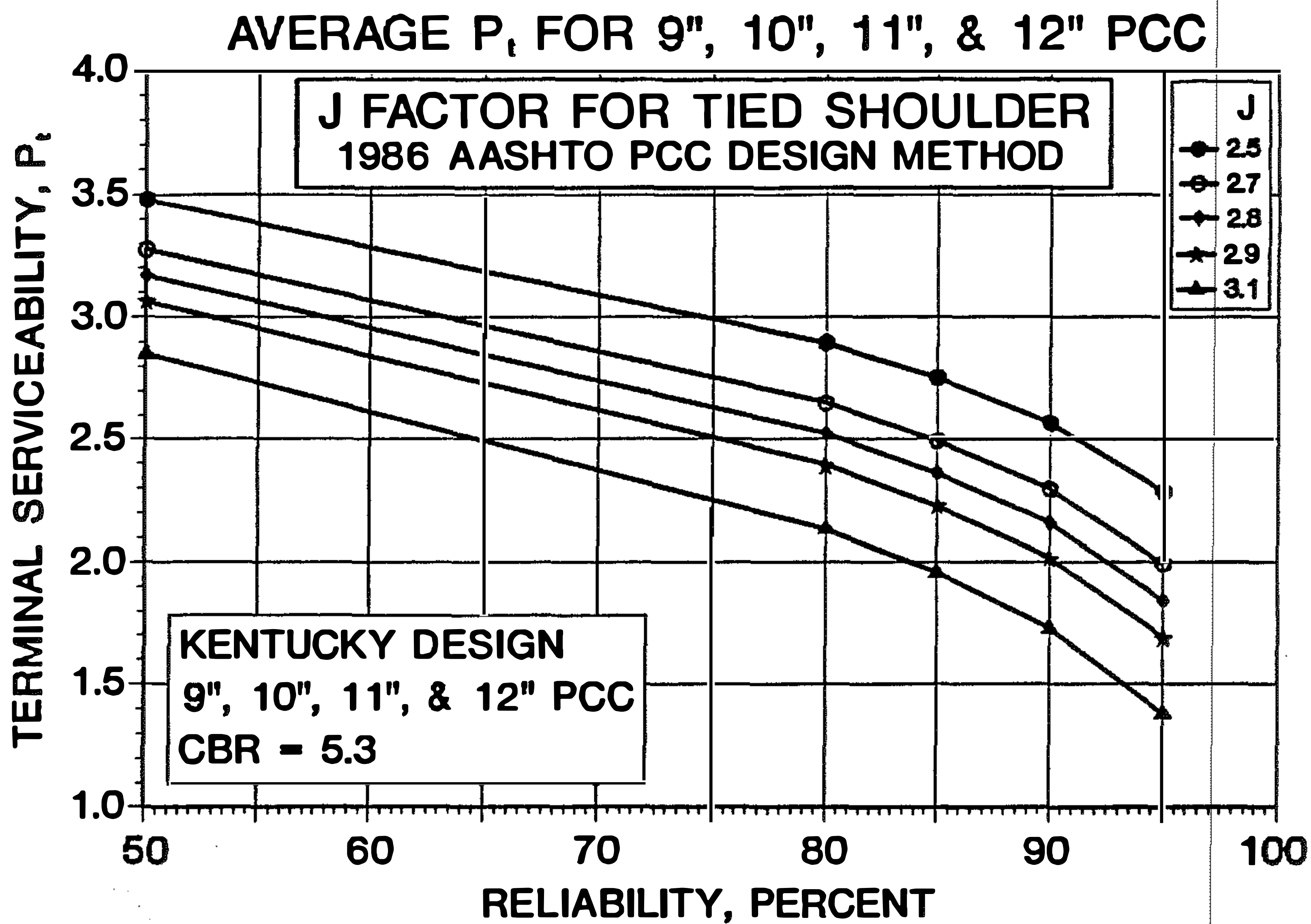


Figure 43. Relationship between Percent Reliability, Average of Terminal Serviceability Values for J Factors for Tied Shoulders for 9-, 10-, 11-, and 12-inch Jointed PCC.

TABLE 1A. KENTUCKY LOAD EQUIVALENCY EQUATIONS

$LEF = 10^{(POWER)}$

WHERE LEF = LOAD EQUIVALENCY FACTOR
POWER = $A + B(X) + C(X)^2$
X = log(LOAD)
LOAD = KIPS
A, B, C = CONSTANTS GIVEN BELOW

TIRE AND AXLE CONFIGURATION	COEFFICIENTS		
	A	B	C
TWO-TIRED STEERING	-3.540112	2.728860	0.289133
FOUR-TIRED SINGLE REAR	-3.439501	0.423747	1.846657
FOUR-TIRED TANDEM	-7.4768139	7.31958101	-1.5377459
SIX-TIRED TANDEM	-7.0425153	5.64606809	-0.51945722
EIGHT-TIRED TANDEM AXLES	-2.979479	-1.265144	2.007989
SIX-TIRED TRIDEM	-8.9876095	8.11598341	-1.65068463
TEN-TIRED TRIDEM	-8.3649958	5.94259543	-0.56377024
TWELVE-TIRED TRIDEM AXLES	-2.740987	-1.873428	1.964442
SIXTEEN TIRE QUAD AXLES	-2.589482	-2.224981	1.923512

NOTE: TOTAL EFFECT OF AXLELOAD = **LEF**(from Table 1A) x **AF**(from Table 1B)

TABLE 1B. ADJUSTMENT FACTORS TO ACCOUNT FOR UNEVEN LOADING IN AXLE GROUP

$AF = 10^{(EXPONENT)}$

WHERE AF = ADJUSTMENT FACTOR FOR UNEVEN LOAD DISTRIBUTION WITHIN AXLE GROUP

NOTE: AF = 1 FOR EVEN LOAD DISTRIBUTION WITHIN AXLE GROUP

$EXPONENT = A + B(X) + C(X)^2$

X = 100(MAX - MIN) / (TOTAL GROUP LOAD)

MAX = LARGEST INDIVIDUAL AXLELOAD IN GROUP

MIN = LEAST INDIVIDUAL AXLELOAD IN GROUP

A, B, C = CONSTANTS GIVEN BELOW

	COEFFICIENTS		
UNEVEN LOAD	A	B	C
TANDEM	0.00186354	0.02421889	-9.06996E-05
TRIDEM	-0.1984291	1.20191282	-0.174635324

NOTE: TOTAL EFFECT OF AXLELOAD = LEF(from Table 1A) x AF(from Table 1B)

TABLE 2. COMPARISON OF KENTUCKY AND AASHTO LOAD EQUIVALENCY RELATIONSHIPS USING THE SAME TRUCK TRAFFIC

DESCRIPTION	NO. OF AXLES OR GROUPS	KENTUCKY 18-KIP EAL LOADING EVEN	KENTUCKY 18-KIP EAL LOADING UNEVEN	KENTUCKY ADJUSTMENT FACTOR FOR TIRE PRESSURE	KY 18-KIP EAL INCLUDING LOAD AND TIRE PRESSURE EVEN	KY 18-KIP EAL INCLUDING LOAD AND TIRE PRESSURE UNEVEN	AASHTO EAL FLEXIBLE	AASHTO EAL RIGID
STEERING	2,972	422.10	422.10	1.8	759.78	759.78	166.57	202.04
SINGLE	1,247	350.21	350.21	1.4	490.30	490.30	335.15	349.26
DRIVE TANDEM	2,304	1,322.96	1,662.15	1.3	1,719.85	2,160.80	1,880.65	3,453.62
TRAILER TANDEM	1,735	906.93	1,364.90	1.3	1,179.01	1,774.37	1.268.44	2,284.38
TRIDEM	102	114.40	533.34	1.3	148.73	693.35	183.50	465.71
TOTAL EAL =	8,378	3,116.61	4,332.71		4,297.65	5,878.60	3,834.31	6,755.01
EAL/TRUCK =		1.049	1.458		1.446	1.978	1.290	2.273
AASHTO/KY -- W/O ADJUSTING FOR TIRE PRESSURE								
EVEN LOADING							1.230	2.167
UNEVEN LOADING							0.885	1.559
AASHTO/KY -- ADJUSTING FOR TIRE PRESSURE								
EVEN LOADING							0.892	1.572
UNEVEN LOADING							0.652	1.149
20-YR DESIGN LIFE REDUCED TO EQUIVALENT NO. OF YEARS TO ACCOUNT FOR LOAD AND TIRE PRESSURE EFFECTS							17.84	31.44
EVEN LOADING							13.05	22.98
UNEVEN LOADING								

TRUCK TRAFFIC DATA

	NO. AXLES PER GROUP	NO. AXLES
STEERING	2,972	2,972
SINGLE	1,247	1,247
DRIVE TANDEM	2,304	4,608
TRAILER TAND	1,753	3,506
TRIDEM	102	306
TOTAL AXLES		12,639

SUMMARY DATA

TOTAL NUMBER OF TRUCKS	2,972
TOTAL NUMBER OF AXLES	12,639
NUMBER OF AXLES PER TRUCK	4.253

APPENDIX A

1981 AND 1987 KENTUCKY PAVEMENT THICKNESS DESIGNS AND CALCULATED 18-KIP EAL 1986 AASHTO GUIDE

THIS PAGE LEFT BLANK

TABLE A1-1. AC PAVEMENT THICKNESS DESIGNS USING 1981 KENTUCKY DESIGN CURVES.

TOTAL PAVEMENT THICKNESS DESIGN, INCHES -- AC THICKNESS = 33% OF TOTAL DESIGN THICKNESS

EAL	CBR 2	3	4	5	6	7	8	9	10	11
10000	13.75	11.92	10.6	9.7	8.65	7.9	7.25	6.6	6	
40000	17.25	15.5	14.25	13.2	12.2	11.5	10.85	10.18	9.6	9.05
100000	19.35	17.7	16.42	15.35	14.38	13.6	12.95	12.28	11.68	11.1
400000	22.25	20.94	19.55	18.4	17.45	16.6	15.9	15.25	14.65	14.1
1000000	24.8	23.12	21.6	20.5	19.5	18.6	17.8	17.2	16.6	16.05
4000000	28.9	26.8	25.2	23.9	22.8	21.85	21.05	20.4	19.75	19.2
10000000	32.4	29.9	28.2	26.75	24.6	24.55	23.7	23	22.3	21.75
40000000			34.2	32.45	31	29.85	29.05	28.1	27.36	26.7

TOTAL PAVEMENT THICKNESS DESIGNS, INCHES -- AC THICKNESS = 50% OF TOTAL DESIGN THICKNESS

EAL	CBR 2	3	4	5	6	7	8	9	10	11
10000	9.5	8.45	7.55	7	6.35	5.85	5.45	5.1	4.7	4.3
40000	12.7	11.6	10.55	9.9	9.2	8.75	8.3	7.8	7.5	7.1
100000	14.7	13.4	12.45	11.7	11	10.45	10	9.5	9.15	8.75
400000	17.75	16.15	15.15	14.35	13.6	13	12.5	12	11.65	11.25
1000000	19.8	18.1	17	16.15	15.4	14.75	14.25	13.8	13.3	12.9
4000000	23.35	21.45	20.25	19.2	18.45	17.75	17.2	16.65	16.2	15.85
10000000	26.1	24.15	22.75	21.7	20.9	20.2	19.4	18.95	18.4	18
40000000			27.85	26.6	25.6	24.75	24.1	23.3	22.8	22.3

TABLE A1-2. AC PAVEMENT THICKNESS DESIGNS USING 1981 KENTUCKY DESIGN CURVES.

TOTAL PAVEMENT THICKNESS DESIGNS, INCHES -- AC THICKNESS = 75% OF TOTAL DESIGN THICKNESS

EAL	CBR 2	3	4	5	6	7	8	9	10	11
10000	7.05	6.3								
40000	9.25	8.6	7.9	7.45	7	6.6	6.3			
100000	10.8	10.05	9.3	8.9	8.45	8.1	7.75	7.4	7.1	6.8
400000	13.2	12.3	11.6	11	10.55	10.2	9.8	9.45	9.15	8.9
1000000	14.9	13.9	13.2	12.6	12.1	11.7	11.25	10.9	10.6	10.3
4000000	17.75	16.7	15.9	15.25	14.75	14.25	13.7	13.4	13.1	12.75
10000000	19.9	18.75	18	17.25	16.75	16.25	15.75	15.35	15	14.65
40000000	23.95	22.75	21.8	21.1	20.5	20	19.5	19	18.6	18.2

AC THICKNESS = 100% OF TOTAL DESIGN THICKNESS, INCHES

EAL	CBR 2	3	4	5	6	7	8	9	10	11
10000	5.9	5.4	5	4.65	4.35	4.05	3.8	3.55	3.3	3.1
40000	7.5	6.9	6.45	6.1	5.8	5.5	5.25	5	4.85	4.6
100000	8.7	8.1	7.5	7.15	6.85	6.55	6.35	6.05	5.9	5.75
400000	10.6	9.85	9.3	8.9	8.55	8.25	8.05	7.75	7.5	7.3
1000000	11.9	11.2	10.65	10.25	9.9	9.5	9.25	9	8.75	8.5
4000000	14.35	13.55	12.9	12.4	12	11.7	11.5	11.1	10.8	10.6
10000000	16.25	15.25	14.6	14.1	13.7	13.35	13	12.7	12.5	12.25
40000000	19.5	18.4	17.75	17.1	16.6	16.2	15.9	15.5	15.2	14.9

TABLE A2-1. PAVEMENT THICKNESS DESIGNS USING 1987 KENTUCKY THICKNESS DESIGN CURVES.

TOTAL PAVEMENT THICKNESS DESIGNS, INCHES -- AC THICKNESS = 33% OF TOTAL DESIGN THICKNESS

	CBR									
EAL	2	3	4	5	6	7	8	9	10	11
10000										
40000	16.25	14.9	13.9	13	12.3					
100000	19.7	17.55	16.1	15	14.1	13.35	12.8	12.3		
400000	24.85	21.8	19.7	18.2	17.15	16.25	15.5	14.9	14.4	13.9
1000000	28.3	24.65	22.3	20.65	19.35	18.4	17.6	17	16.4	15.9
4000000	33.7	29.3	26.5	24.55	23.1	22	21.05	20.35	19.75	19.2
10000000	37.25	32.45	29.4	27.35	25.8	24.55	23.6	22.8	22.2	21.5
40000000		37.5	34.2	31.9	30.2	28.9	27.85	26.9	26.15	25.5

TOTAL PAVEMENT THICKNESS DESIGNS, INCHES -- AC THICKNESS = 50% OF TOTAL DESIGN THICKNESS

	CBR									
EAL	2	3	4	5	6	7	8	9	10	11
10000	8.5	8.4	8.3	8.15	8					
40000	12.5	11.65	11	10.4	9.9	9.5	9.1	8.8	8.55	8.15
100000	15.1	13.8	12.8	12.1	11.4	10.9	10.5	10.1	9.8	9.5
400000	19.15	17.15	15.8	14.8	14.1	13.4	12.95	12.55	12.1	11.8
1000000	21.85	19.4	17.9	16.8	15.9	15.25	14.75	14.25	13.9	13.5
4000000	25.95	23.1	21.3	20	19.1	18.25	17.75	17.25	16.8	16.35
10000000	28.7	25.7	23.75	22.35	21.35	20.5	19.9	19.3	18.9	18.5
40000000	32.75	29.6	27.6	26.15	25	24.15	23.4	22.85	22.3	21.9

TABLE A2-2. PAVEMENT THICKNESS DESIGNS USING 1987 KENTUCKY THICKNESS DESIGN CURVES.

TOTAL PAVEMENT THICKNESS DESIGNS, INCHES -- AC THICKNESS = 75% OF TOTAL DESIGN THICKNESS

	CBR									
EAL	2	3	4	5	6	7	8	9	10	11
10000										
40000	8									
100000	11.2	9.8	8.8	8.25						
400000	14.05	12.65	11.7	11	10.35	9.9	9.5	9.15	8.9	8.6
1000000	15.9	14.45	13.5	12.8	12.25	11.8	11.4	11.1	10.75	10.5
4000000	18.85	17.3	16.35	15.65	15.1	14.7	14.25	13.95	13.65	13.4
10000000	20.75	19.25	18.3	17.6	17	16.6	16.2	15.9	15.6	15.3
40000000	23.55	22.15	21.2	20.5	19.9	19.5	19.1	18.8	18.5	18.3

TOTAL PAVEMENT THICKNESS DESIGNS, INCHES -- ASPHALTIC CONCRETE ON 4" CRUSHED STONE BASE

	CBR									
EAL	2	3	4	5	6	7	8	9	10	11
10000	8.25	8.1								
40000	10.6	10.1	9.75	9.4	9.15	8.85	8.7	8.5	8.3	8.1
100000	12.1	11.4	10.9	10.5	10.2	9.9	9.65	9.4	9.15	8.95
400000	14.4	13.4	12.8	12.3	11.9	11.65	11.3	11.05	10.8	10.55
1000000	15.9	14.85	14.2	13.65	13.2	12.8	12.5	12.2	12	11.8
4000000	18.2	17.1	16.25	15.75	15.25	14.9	14.6	14.3	14.1	13.85
10000000	19.7	18.55	17.8	17.2	16.75	16.3	16.1	15.8	15.6	15.35
40000000	22.85	20.8	20.2	19.65	19.2	18.85	18.6	18.3	18.1	17.8

TABLE A3-1. 18-KIP DESIGN EAL BY 1986 AASHTO DESIGN EQUATION AT TERMINAL SERVICEABILITY OF 3.5, STANDARD ERROR = 0.50.

50% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	90.3925839	168.097564	261.050223	367.283433	485.459148	614.588879	753.902768	902.778713	1060.70009	1227.22877
2	3013.24506	5603.54771	8702.13311	12243.4268	16182.8251	20487.3765	25131.4178	30094.2110	35358.5348	40909.7836
3	20554.8088	38224.5219	59361.4787	83518.3643	110390.914	139754.351	171433.613	205287.237	241197.748	279065.514
4	64412.2134	119783.457	186019.936	261719.909	345929.908	437945.551	537218.253	643304.712	755836.795	874502.292
5	185773.505	345471.636	536506.571	754835.497	997708.485	1263094.00	1549409.85	1855377.50	2179935.19	2522182.48
6	562840.700	1046680.45	1625461.78	2286936.11	3022771.94	3826814.32	4694269.63	5621264.27	6604581.46	7641493.06
7	1671373.47	3108151.11	4826860.79	6791129.98	8976218.05	11363847.6	13939783.9	16692524.1	19612516.0	22691658.2
8	4647672.65	8642992.83	13422295.6	18884438.2	24960623.0	31600025.1	38763061.4	46417745.3	54537514.2	63099840.5

80% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	34.3267590	63.8353761	99.1343286	139.476595	184.354053	233.391318	286.296038	342.831966	402.802917	466.042507
2	1144.28565	2127.95810	3304.65192	4649.46509	6145.45923	7780.12097	9543.70465	11428.3350	13427.4721	15535.5696
3	7805.72851	14515.8363	22542.6366	31716.2608	41921.1638	53071.9858	65102.2471	77958.2266	91595.3125	105975.670
4	24460.6629	45488.0001	70641.4316	99388.6431	131367.553	166310.672	204009.673	244296.211	287030.488	332093.941
5	70547.8490	131193.523	203739.410	286650.243	378881.731	479662.397	588391.397	704583.204	827834.618	957803.690
6	213739.847	397478.932	617272.263	868468.423	1147903.50	1453240.15	1782657.99	2134686.00	2508102.61	2901871.80
7	634707.317	1180326.41	1833009.74	2578944.78	3408736.20	4315443.16	5293659.97	6339018.42	7447890.99	8617201.21
8	1764962.70	3282193.28	5097142.80	7171402.04	9478844.99	12000170.8	14720347.7	17627228.7	20710726.7	23962286.7

TABLE A3-2. 18-KIP DESIGN EAL BY 1986 AASHTO DESIGN EQUATION AT TERMINAL SERVICEABILITY OF 3.5, STANDARD ERROR = 0.50.

90% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3283.22239	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	20.6601181	38.4203592	59.6656079	83.9462575	110.956484	140.470360	100.418871	206.338994	242.433486	280.495262
2	688.706931	1280.74619	1988.95850	2798.35618	3698.74458	4682.59233	3347.47229	6878.32928	8081.54248	9350.33525
3	4698.00465	8736.59216	13567.6524	19088.9473	25230.9342	31942.2378	22834.7351	46920.4265	55128.1284	63783.1805
4	14722.0478	27377.6926	42516.6944	59818.6712	79065.6985	100096.782	71556.7752	147033.648	172753.967	199876.139
5	42460.3702	78960.9559	122623.877	172525.110	228036.132	288692.614	206379.385	424064.859	498245.728	576469.727
6	128642.803	239229.159	371515.350	522701.844	690884.394	874656.223	625270.632	1284795.49	1509542.34	1746538.74
7	382008.921	710398.646	1103226.72	1552179.85	2051603.32	2597319.65	1856761.15	3815241.33	4482634.31	5186402.69
8	1062271.50	1975441.40	3067798.29	4316224.94	5704997.01	7222497.97	5163189.55	10609234.3	12465087.7	14422091.9

95% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	12.0401750	22.3903777	34.7715515	48.9216773	64.6625295	81.8624423	102.217043	120.248954	141.283878	163.465282
2	401.360338	746.385294	1159.11285	1630.80859	2155.53134	2728.89201	3823.48637	4008.50992	4709.71101	5449.13017
3	2737.87390	5091.45679	7906.87204	11124.5379	14703.9267	18615.0985	35507.1176	27343.9940	32127.2275	37171.1648
4	8579.62337	15955.0012	24777.6145	34860.7528	46077.4155	58333.7800	162361.389	85687.3540	100676.481	116482.572
5	24744.7902	46016.3743	71461.9801	100543.110	132893.477	168242.484	606378.511	247133.879	290364.543	335951.439
6	74969.6519	139416.480	216509.403	304616.927	402629.306	509726.709	2099562.53	748745.117	879721.692	1017836.97
7	222624.781	414001.701	642931.602	904569.714	1195620.61	1513649.77	6649865.62	2223422.59	2612361.72	3022499.47
8	619063.975	1151235.44	1787832.38	2515382.70	3324722.64	4209082.40	19089745.6	6182783.53	7264326.22	8404816.99

TABLE A4-1. 18-KIP DESIGN EAL BY 1986 AASHTO DESIGN EQUATION AT TERMINAL SERVICEABILITY OF 3.0, STANDARD ERROR = 0.50.

50% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	92.0112175	171.107638	265.724773	373.860270	494.152123	625.594142	767.402685	918.944507	1079.69374	1249.20440
2	3441.73168	6400.37809	9939.58560	13984.4550	18484.0399	23400.7030	28705.1319	34373.6395	40386.5556	46727.1979
3	31961.9216	59437.6325	92304.7713	129867.781	171653.542	217312.535	266572.545	319213.603	375053.039	433935.930
4	146150.471	271787.101	422076.808	593839.059	784910.448	993692.742	1218941.20	1459649.99	1714983.82	1984234.29
5	545834.856	1015055.72	1576349.57	2217837.91	2931440.97	3711189.76	4552435.51	5451421.65	6405028.58	7410610.62
6	1889932.42	3514591.84	5458050.44	7679179.42	10150002.8	12849853.4	15762634.8	18875340.1	22177167.8	25658957.4
7	5985912.06	11131634.8	17287078.3	24321976.8	32147723.2	40698858.5	49924401.7	59783156.4	70240911.5	81268653.0
8	17183736.5	31955544.7	49625954.5	69821012.6	92286355.1	116834068.	143317803.	171619295.	201640335.	233297633.

80% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	34.9414382	64.9784575	100.909498	141.974162	187.655227	237.570588	291.422657	348.970958	410.015791	474.387794
2	1307.00428	2430.55599	3774.57690	5310.62393	7019.35001	8886.46237	10900.8295	13053.4562	15336.8728	17744.7440
3	12137.6017	22571.5561	35052.9158	49317.5416	65185.7656	82524.8566	101231.441	121221.985	142427.118	164788.010
4	55500.9250	103211.678	160284.486	225511.334	298071.264	377356.745	462895.286	554304.916	651268.432	753516.819
5	207281.845	385469.380	598621.807	842228.248	1113220.39	1409331.50	1728796.21	2070187.94	2432322.02	2814193.75
6	717705.504	1334673.06	2072705.24	2916183.27	3854483.27	4879756.74	5985891.13	7167947.00	8421822.49	9744038.83
7	2273161.71	4227259.92	6564801.53	9236317.86	12208160.2	15455470.4	18958888.3	22702769.5	26674122.3	30861928.5
8	6525557.26	12135180.0	18845552.4	26514664.9	35045922.3	44367964.1	54425213.6	65172760.1	76573308.4	88595228.8

TABLE A4-2. 18-KIP DESIGN EAL BY 1986 AASHTO DESIGN EQUATION AT TERMINAL SERVICEABILITY OF 3.0, STANDARD ERROR = 0.50.

90% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3283.22239	4289.76328	4598.44091	4896.76524
SN	18-KIP EAL									
1	21.0300728	39.1083414	60.7340225	85.4494586	112.943350	142.985722	175.397465	210.033846	246.774672	285.518009
2	786.641782	1462.86965	2271.79049	3196.28537	4224.70996	5348.46189	6560.84151	7856.43495	9230.74633	10679.9627
3	7305.21298	13585.0581	21097.1674	29682.5645	39233.1131	49668.9270	60927.7891	72959.4231	85722.0777	99180.3442
4	33404.1343	62119.6273	96469.8248	135727.784	179399.038	227118.294	278601.056	333617.428	391976.497	453516.351
5	124755.949	232001.015	360290.270	506908.768	670009.799	848229.088	1040504.11	1245976.28	1463932.56	1693768.27
6	431962.729	803294.692	1247491.35	1755152.33	2319883.44	2936960.95	3602705.92	4314145.47	5068810.83	5864608.23
7	1368139.34	2544245.13	3951132.56	5559028.11	7347679.78	9302126.23	11410715.2	13664031.0	16054254.3	18574753.6
8	3927512.76	7303755.48	11342502.2	15958282.2	21092958.2	26703580.7	32756699.9	39225285.5	46086891.0	53322479.2

95% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN	18-KIP EAL									
1	12.2557749	22.7913157	35.3937703	49.7977035	65.8204225	83.3283291	102.217043	122.402217	143.813807	143.813807
2	458.434200	852.522069	1323.92401	1862.71129	2462.05017	3116.94332	3823.48637	4578.52425	5379.43688	5379.43688
3	4257.28654	7917.01563	12294.7282	17298.2201	22864.0294	28945.7481	35507.1176	42518.8384	49956.5788	49956.5788
4	19467.0534	36201.6897	56219.4085	79098.5932	104549.054	132358.585	162361.389	194423.488	228433.623	228433.623
5	72704.4955	135204.107	209965.198	295413.136	390464.139	494325.667	606378.511	726122.3	853141.507	853141.507
6	251736.550	468139.079	726996.513	1022856.74	1351967.23	1711583.82	2099562.53	2514170.84	2953970.02	2953970.02
7	797315.730	1482719.34	2302588.77	3239655.80	4282035.08	5421035.21	6649865.62	7963038.97	9355998.40	9355998.40
8	2288851.43	4256437.15	6610033.43	9300068.41	12292422.9	15562146.5	19089745.6	22859467.7	26858231.4	26858231.4

TABLE A5-1. 18-KIP DESIGN EAL BY 1986 AASHTO DESIGN EQUATION AT TERMINAL SERVICEABILITY OF 2.5, STANDARD ERROR = 0.50.

50% RELIABILITY

	2	3	4	5	6	7	8	9	10	11
CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	93.0725845	173.081397	268.789959	378.172820	499.852263	632.810490	776.254822	929.544708	1092.14821	1263.61421
2	3750.51594	6974.60532	10831.3424	15239.1082	20142.3855	25500.1604	31280.4904	37457.5635	44009.9447	50919.4548
3	42513.2718	79059.3337	122776.655	172740.060	228320.243	289052.297	354574.146	424593.203	498866.494	577187.953
4	248166.743	461500.528	716695.786	1008351.89	1332795.35	1687312.32	2069789.21	2478518.08	2912080.58	3369273.85
5	1095315.29	2036890.92	3163227.45	4450488.57	5882460.79	7447166.24	9135276.35	10939252.8	12852835.7	14870716.0
6	4134221.47	7688159.03	11939468.8	16798181.7	22203100.6	28109015.4	34480715.9	41289749.4	48512487.6	56128891.7
7	13651149.0	25386207.7	39423981.1	55467392.2	73314368.6	92815627.7	113854905.	136338251.	160187644.	185336918.
8	40002813.7	74390788.1	115526551.	162539559.	214837667.	271983423.	333636131.	399520481.	469407847.	543104334.

80% RELIABILITY

	2	3	4	5	6	7	8	9	10	11
CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	35.3444944	65.7279964	102.073508	143.611861	189.819866	240.311010	294.784273	352.996405	414.745402	479.859948
2	1424.26570	2648.61989	4113.22327	5787.08091	7649.10997	9683.73536	11878.8268	14224.5824	16712.8618	19336.7617
3	16144.4974	30022.9352	46624.6729	65598.3729	86705.0550	109768.170	134650.219	161240.092	189445.518	219188.244
4	94241.8021	175255.720	272166.614	382923.588	506131.621	640760.126	786006.467	941222.047	1105868.24	1279488.27
5	415948.107	773513.277	1201241.75	1690081.66	2233875.89	2828075.82	3469138.90	4154202.48	4880889.31	5647183.26
6	1569978.62	2919593.30	4534036.44	6379142.10	8431670.51	10674453.1	13094118.7	15679862.4	18422711.2	21315055.4
7	5184050.33	9640461.62	14971333.2	21063849.7	27841273.6	35246914.5	43236621.1	51774715.2	60831568.7	70382054.3
8	15191146.0	28250046.0	43871431.7	61724712.7	81585020.7	103286232.	126698967.	151718677.	178258540.	206244923.

TABLE A5-2. 18-KIP DESIGN EAL BY 1986 AASHTO DESIGN EQUATION AT TERMINAL SERVICEABILITY OF 2.5, STANDARD ERROR = 0.50.

90% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3283.22239	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	21.2726587	39.5594636	61.4346010	86.4351345	114.246173	144.635090	177.420709	212.456627	249.621265	288.811513
2	857.217476	1594.11495	2475.61032	3483.04876	4603.74123	5828.31361	7149.46514	8561.29625	10058.9076	11638.1445
3	9716.82832	18069.7918	28061.8176	39481.4475	52184.8474	66065.7585	81041.4245	97044.9718	114020.866	131922.009
4	56720.9612	105480.505	163807.903	230468.789	304623.547	385651.902	473070.775	566489.796	665584.790	770080.828
5	250345.133	465551.545	722986.888	1017203.13	1344494.53	1702123.42	2087957.66	2500274.32	2937642.61	3398849.08
6	944917.165	1757204.71	2728883.57	3839390.41	5074738.02	6424593.21	7880908.32	9437180.18	11088008.3	12828812.7
7	3120105.00	5802268.61	9010740.41	12677620.5	16756723.3	21213928.7	26022663.5	31161454.3	36612468.9	42360584.0
8	9143038.31	17002749.6	26404734.6	37150022.2	49103271.5	62164498.6	76255834.2	91314353.4	107287801.	124131861.

95% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	12.3971476	23.0542179	35.8024743	50.3721296	66.5796737	84.2895373	103.396136	123.814150	145.472727	168.311776
2	499.563864	929.008391	1442.72077	2029.82947	2682.93965	3396.58832	4166.52079	4989.29893	5862.06761	6782.40540
3	5662.71272	10530.6008	16353.6913	23008.7522	30411.9605	38501.3914	47228.8169	56555.2645	66448.3706	76880.6875
4	33055.4887	61471.2724	95462.9500	134311.166	177526.614	224747.815	275693.241	330135.396	387885.360	448782.911
5	145894.578	271311.231	421337.797	592799.311	783536.155	991952.894	1216806.97	1457094.30	1711981.07	1980760.11
6	550672.943	1024052.82	1590321.78	2237496.04	2957424.23	3744084.43	4592786.69	5499741.12	6461800.49	7476295.65
7	1818315.37	3381409.98	5251223.20	7388184.76	9765378.9	12362921.3	15165325.8	18160078.3	21336786.7	24686637.4
8	5328322.95	9908756.58	15387986.9	21650058.6	28616098.9	36227839.5	44439900.3	53215610.4	62524517.0	72340793.5

TABLE A6-1. 18-KIP DESIGN EAL BY 1986 AASHTO DESIGN EQUATION AT TERMINAL SERVICEABILITY OF 2.0, STANDARD ERROR = 0.50.

50% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	93.8661243	174.557095	271.081671	381.397133	504.114019	638.205852	504.114019	937.470035	1101.45990	1274.38782
2	3996.79784	7432.60071	11542.5948	16239.8016	21465.0582	27174.6574	21465.0582	39917.2571	46899.9078	54263.1388
3	52508.9786	97647.7388	151643.863	213354.648	282002.825	357014.181	282002.825	524423.421	616159.824	712896.200
4	367245.012	682943.108	1060589.13	1492191.09	1972312.80	2496938.25	1972312.80	3667789.60	4309389.14	4985958.22
5	1834189.21	3410929.59	5297066.23	7452683.41	9850630.38	12470849.2	9850630.38	18318615.3	21523056.2	24902151.0
6	7379637.74	13723461.3	21312103.2	29984967.4	39632816.1	50174949.0	39632816.1	73702726.2	86595405.5	100190783.
7	25130575.2	46733795.1	72576112.0	102110632.	134965360.	170865478.	134965360.	250986833.	294891487.	341189108.
8	74771668.0	139048301.	215937633.	303812478.	401566021.	508380595.	401566021.	746767791.	877398476.	1015149016

80% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	35.6458427	66.2883954	102.943790	144.836300	191.438276	242.359910	297.297613	356.006063	418.281534	483.951249
2	1517.79173	2822.54453	4383.32276	6167.09616	8151.39748	10319.6288	12658.8635	15158.6557	17810.3309	20606.5321
3	19940.3864	37081.9181	57587.0510	81021.8413	107091.119	135576.827	166309.136	199150.811	233987.888	270723.714
4	139462.005	259348.969	402760.781	566662.462	748989.613	948217.143	1163157.28	1392850.21	1636498.88	1893427.30
5	696536.910	1295307.12	2011571.17	2830170.97	3740795.98	4735829.20	5809338.35	6956529.70	8173422.35	9456640.16
6	2802431.74	5211511.06	8093312.54	11386849.5	15050638.7	19054034.1	23373168.0	27988753.2	32884773.1	38047644.2
7	9543384.68	17747249.3	27560919.2	38776710.8	51253357.3	64886496.6	79594849.7	95312736.6	111985614.	129567225.
8	28394685.9	52803862.2	82002735.0	115373377.	152495475.	193058516.	236820670.	283586516.	333193772.	385504807.

TABLE A6-2. 18-KIP DESIGN EAL BY 1986 AASHTO DESIGN EQUATION AT TERMINAL SERVICEABILITY OF 2.0, STANDARD ERROR = 0.50.

90% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3283.22239	4289.76328	4598.44091	4896.76524
SN	18-KIP EAL									
1	21.4540301	39.8967488	61.9583944	87.1720831	115.220239	145.868253	178.933403	214.268039	251.749544	291.273929
2	913.507637	1698.79433	2638.17409	3711.76712	4906.05114	6211.03646	7618.94291	9123.48351	10719.4373	12402.3765
3	12001.4458	22318.3555	34659.7032	48764.3128	64454.5320	81599.1185	100095.858	119862.154	140829.415	162939.470
4	83937.4761	156093.395	242408.126	341055.018	450791.579	570699.908	700065.126	838309.553	984953.467	1139590.01
5	419222.067	779601.66	1210696.82	1703384.42	2251458.90	2850335.82	3496444.76	4186900.53	4919307.17	5691632.67
6	1686689.12	3136632.68	4871091.77	6853360.57	9058471.71	11467980.3	14067521.2	16845486.2	19792235.5	22899593.4
7	5743841.27	10681470.6	16587987.4	23338394.0	30847666.6	39052993.2	47905454.7	57365520.6	67400363.2	77982141.8
8	17089803.5	31780863.2	49354679.7	69439343.7	91781881.8	116195408.	142534371.	170681157.	200538090.	232022337.

95% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN	18-KIP EAL									
1	12.5028461	23.2507789	36.1077273	50.8016039	67.1473341	85.0081926	104.277695	124.869794	146.713032	169.746807
2	532.368294	990.012784	1537.45867	2163.12053	2859.11794	3619.62916	4440.12012	5316.92692	6247.00695	7227.77977
3	6994.12791	13006.5522	20198.7660	28418.5626	37562.4109	47553.8263	58333.2412	69852.5202	82071.6902	94956.8501
4	48916.5598	90967.1371	141269.098	198757.920	262709.510	332588.939	407979.596	488544.823	574005.049	664123.175
5	244311.626	454331.402	705562.358	992687.773	1312091.20	1661100.96	2037636.31	2440015.82	2866843.20	3316934.25
6	982958.185	1827947.27	2838744.54	3993958.81	5279039.75	6683238.19	8198182.47	9817107.63	11534395.8	13345282.5
7	3347360.06	6224880.95	9667044.07	13601004.0	17977211.1	22759060.2	27918042.7	33431120.9	39279164.0	45445947.1
8	9959489.30	18521053.6	28762613.0	40467428.4	53488073.7	67715636.5	83065293.9	99468502.1	116868340.	135216533.

TABLE A7-1. 18-KIP DESIGN EAL BY 1986 AASHTO DESIGN EQUATION AT TERMINAL SERVICEABILITY OF 1.5, STANDARD ERROR = 0.50.

50% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN	18-KIP EAL									
1	94.5012537	175.738206	272.915900	383.977793	507.525022	642.524166	788.170375	943.813270	253.452965	1283.01076
2	4203.89398	7817.72474	12140.6803	17081.2753	22577.2812	28582.7263	35061.8067	41985.5903	11274.8704	57074.8112
3	62098.1025	115480.046	179336.875	252317.206	333501.827	422211.663	517917.835	620192.969	166547.507	843084.410
4	501367.353	932362.229	1447929.17	2037157.41	2692625.41	3408850.44	4181562.46	5007310.93	1344670.44	6806890.75
5	2762437.84	5137136.84	7977811.73	11224346.1	14835848.9	18782111.3	23039606.1	27589321.7	7408875.91	37504660.9
6	11692690.8	21744182.5	33768030.7	47509778.2	62796343.1	79499859.6	97520743.2	116778522.	31359871.3	158747609.
7	40805536.2	75883562.1	117844782.	165801183.	219148740	277441219.	340331091.	407537519.	109440708.	554002619.
8	122887214.	228525842.	354893436.	499315718.	659973637.	835523357.	1024918273	1227312643	329584292.	1668397108

80% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN	18-KIP EAL									
1	35.8870343	66.7369247	103.640342	145.816311	192.733611	243.999797	299.309228	358.414919	421.111767	487.225824
2	1596.43689	2968.79613	4610.44689	6486.64743	8573.76634	10854.3457	13314.7891	15944.1093	18733.1824	21674.2702
3	23581.8748	43853.7715	68103.5261	95817.9484	126647.965	160335.697	196680.302	235519.482	276718.462	320162.939
4	190395.224	354066.364	549853.913	773614.479	1022529.72	1294517.56	1587956.45	1901536.03	2234168.15	2584929.96
5	1049041.12	1950837.67	3029589.47	4262467.22	5633942.41	7132543.20	8749335.12	10477098.4	12309837.5	14242467.7
6	4440322.00	8257395.49	12823475.1	18041930.4	23847033.0	30190225.8	37033691.3	44346870.1	52104384.7	60284712.5
7	15495981.5	28816929.8	44751784.5	62963321.0	83222158.9	105358841.	129241391.	154763163.	181835592.	210383568.
8	46666657.9	86783131.9	134771470.	189616112.	250626268.	317291615.	389214701.	466074356.	547603866.	633577036.

TABLE A7-2. 18-KIP DESIGN EAL BY 1986 AASHTO DESIGN EQUATION AT TERMINAL SERVICEABILITY OF 1.5, STANDARD ERROR = 0.50.

90% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3283.22239	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	21.5991952	40.1667035	62.3776255	87.7619185	115.999858	146.855246	180.144126	215.717848	253.452965	293.244786
2	960.841505	1786.81823	2774.87244	3904.09424	5160.26071	6532.86451	8013.72236	9596.22150	11274.8704	13045.0120
3	14193.1348	26394.1056	40989.2147	57669.5905	76225.1378	96500.6472	118375.238	141751.230	166547.507	192695.272
4	114592.462	213100.599	330938.519	465612.455	615426.142	779126.449	955737.416	1144470.38	1344670.44	1555782.13
5	631382.462	1174143.38	1823407.69	2565435.22	3390879.86	4292837.12	5265929.63	6305812.07	7408875.91	8572060.81
6	2672480.01	4969847.76	7718017.05	10858829.2	14352724.6	18170478.4	22289329.4	26690885.0	31359871.3	36283334.6
7	9326508.47	17343937.8	26934589.3	37895498.7	50088609.7	63411932.0	77786033.4	93146726.7	109440708.	126622772.
8	28087086.9	52231839.3	81114401.4	114123540.	150843495.	190967118.	234255197.	280514431	329584292.	381328643.

95% RELIABILITY

CBR =	2	3	4	5	6	7	8	9	10	11
MR =	1590.87682	2078.59358	2512.85411	2911.25261	3283.22239	3634.56155	3969.15441	4289.76328	4598.44091	4896.76524
SN					18-KIP EAL					
1	12.5874445	23.4081014	36.3520443	51.1453445	67.6016753	85.5833863	104.983272	125.714704	147.705741	170.895371
2	559.953231	1041.31080	1617.12288	2275.20374	3007.26461	3807.18211	4670.18723	5592.42623	6570.69883	7602.29090
3	8271.38678	15381.7925	23887.4394	33608.3249	44422.0113	56238.0464	68985.9845	82608.8999	97059.5193	112297.751
4	66781.4818	124189.440	192862.290	271346.728	358654.216	454054.461	556978.701	666967.328	783638.668	906669.028
5	367953.141	684259.971	1062634.18	1495068.36	1976115.85	2501752.89	3068845.69	3674861.90	4317698.58	4995572.24
6	1557451.26	2896296.94	4497857.93	6328240.90	8364391.54	10589278.2	12989636.6	15554747.8	18275710.5	21144975.9
7	5435244.55	10107592.1	15696772.2	22084502.8	29190328.2	36954810.9	45331660.3	54283469.5	63779174.7	73792431.0
8	16368417.7	30439346.1	47271345.9	66508206.6	87907633.3	111290628.	136517785.	163476453.	192073082.	222228332.

APPENDIX B

1981 AND 1987 KENTUCKY THICKNESS DESIGN CURVES SUPERIMPOSED ON FAMILY OF 1986 AASHTO DESIGN ON SAME SUBGRADE

THIS PAGE LEFT BLANK

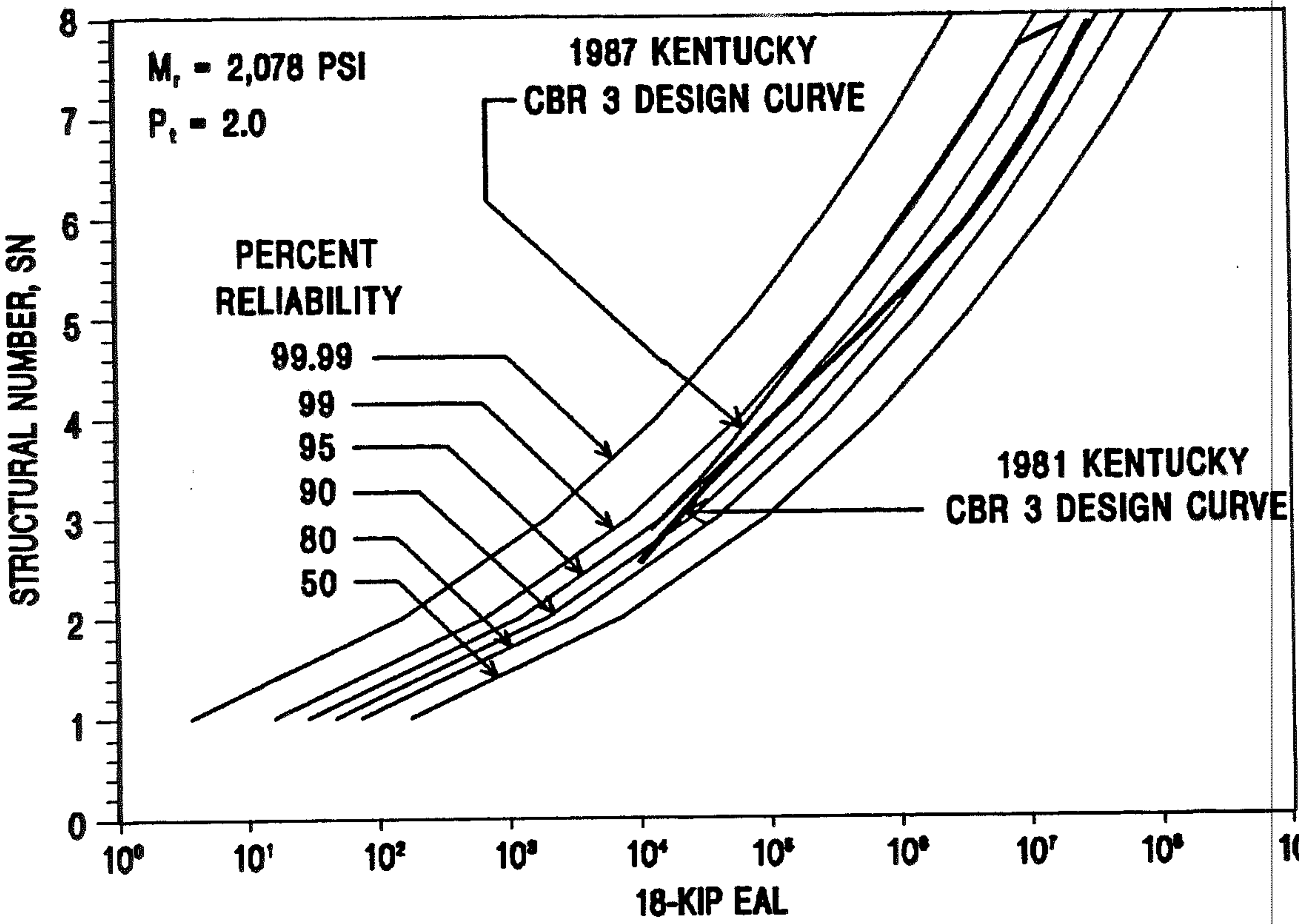


Figure B1. The 1981 and 1987 Kentucky Thickness Design Curve for CBR 3 (M_r of 2,078 psi) Superimposed on a Family of AASHTO Design Curves at Various Reliability Percentages and 2.0 Serviceability Level.

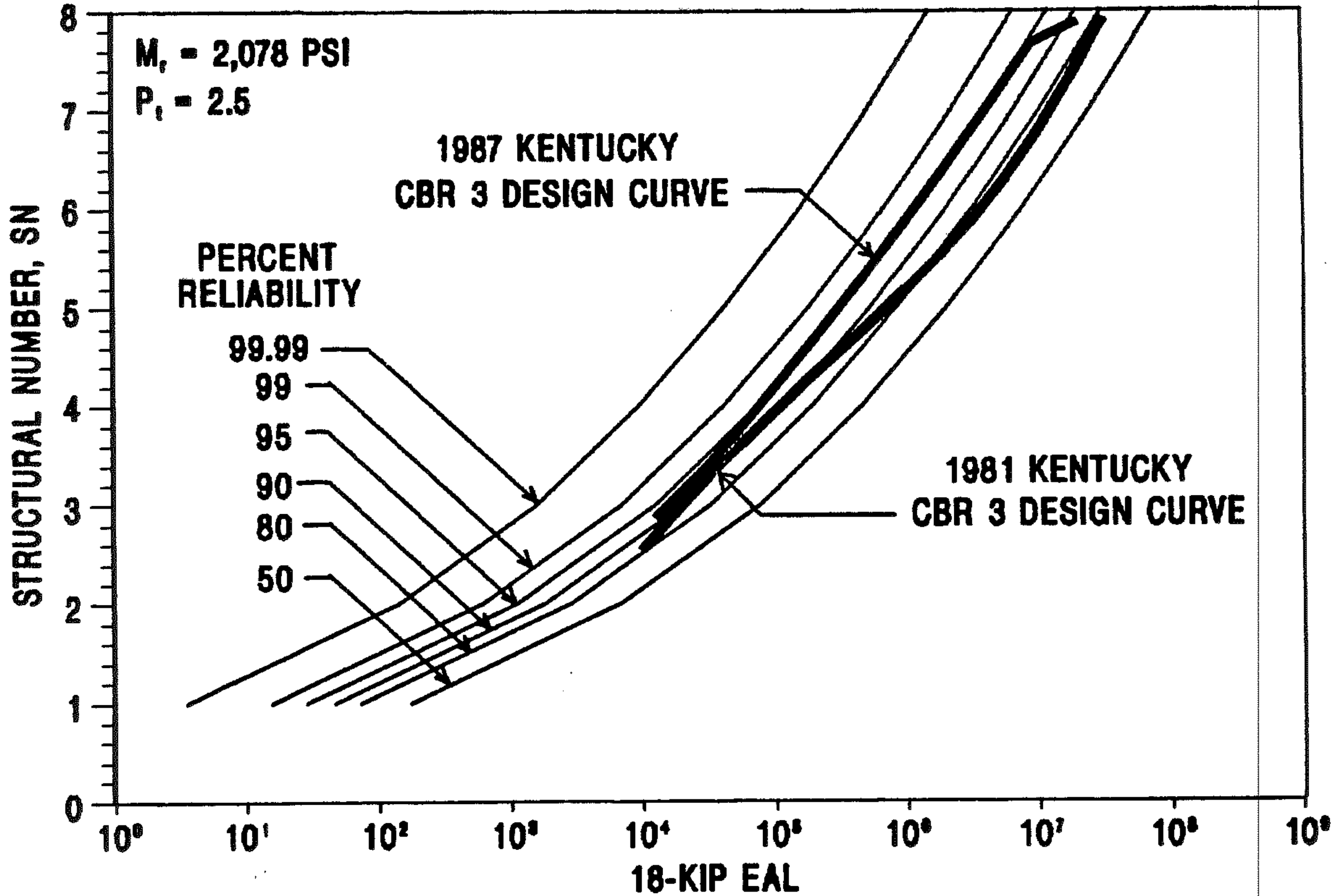


Figure B2. The 1981 and 1987 Kentucky Thickness Design Curve for CBR 3 (M_T of 2,078 psi) Superimposed on a Family of AASHTO Design Curves at Various Reliability Percentages and 2.5 Serviceability Level.

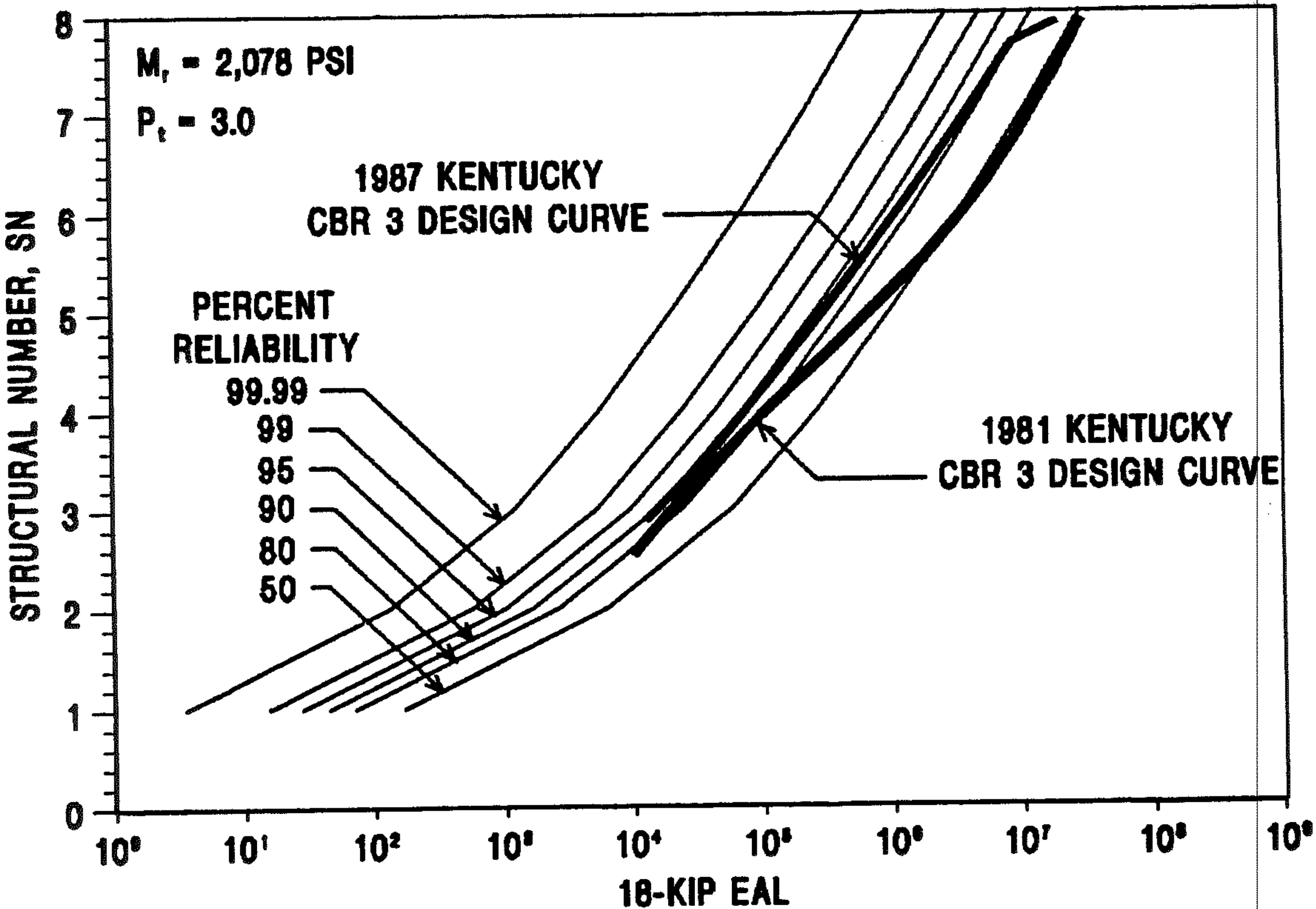


Figure B3. The 1981 and 1987 Kentucky Thickness Design Curve for CBR 3 (M_r of 2,078 psi) Superimposed on a Family of AASHTO Design Curves at Various Reliability Percentages and 3.0 Serviceability Level.

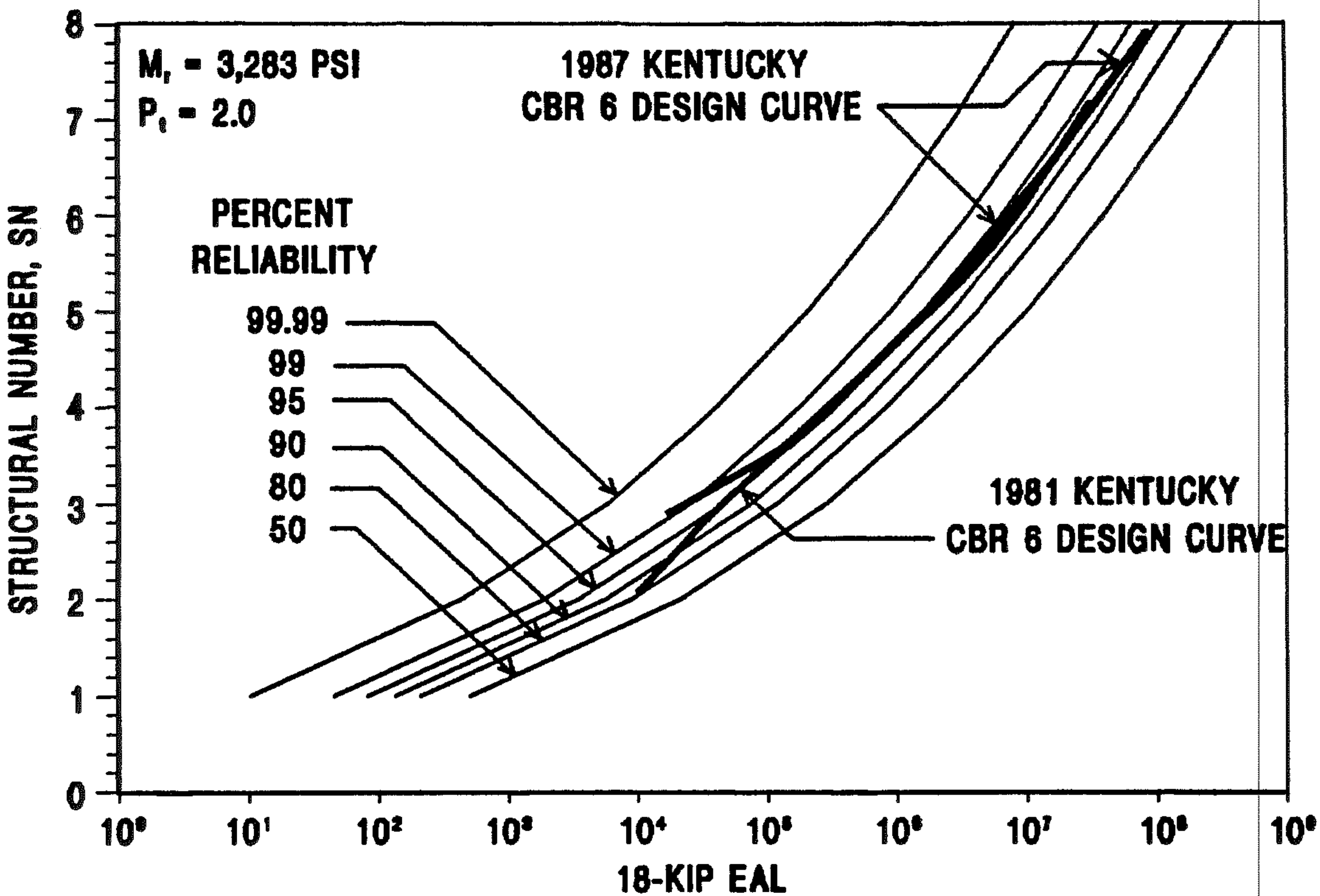


Figure B4. The 1981 and 1987 Kentucky Thickness Design Curve for CBR 6 (M_r of 3,283 psi) Superimposed on a Family of AASHTO Design Curves at Various Reliability Percentages and 2.0 Serviceability Level.

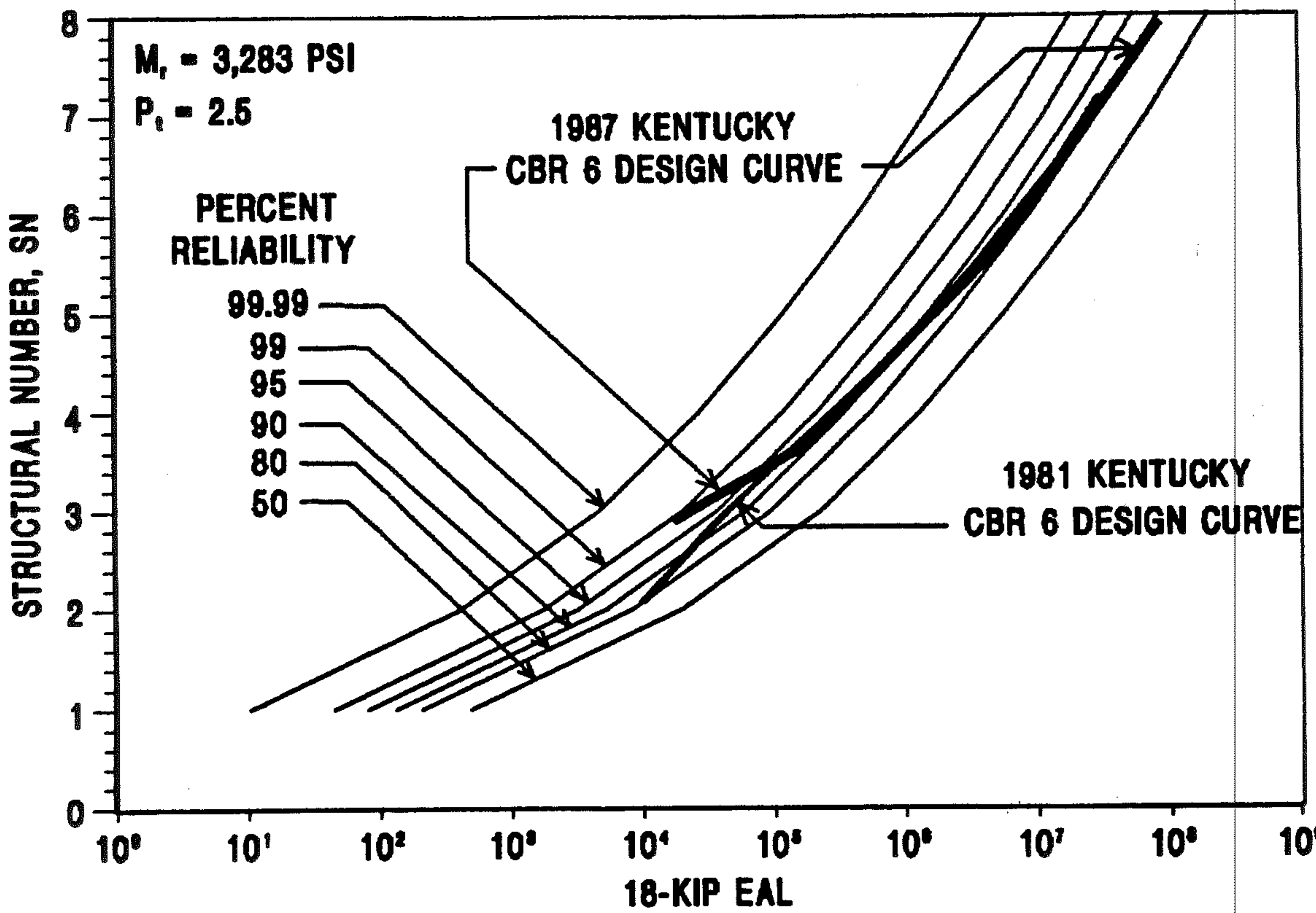


Figure B5. The 1981 and 1987 Kentucky Thickness Design Curve for CBR 6 (M_r of 3,283 psi) Superimposed on a Family of AASHTO Design Curves at Various Reliability Percentages and 2.5 Serviceability Level.

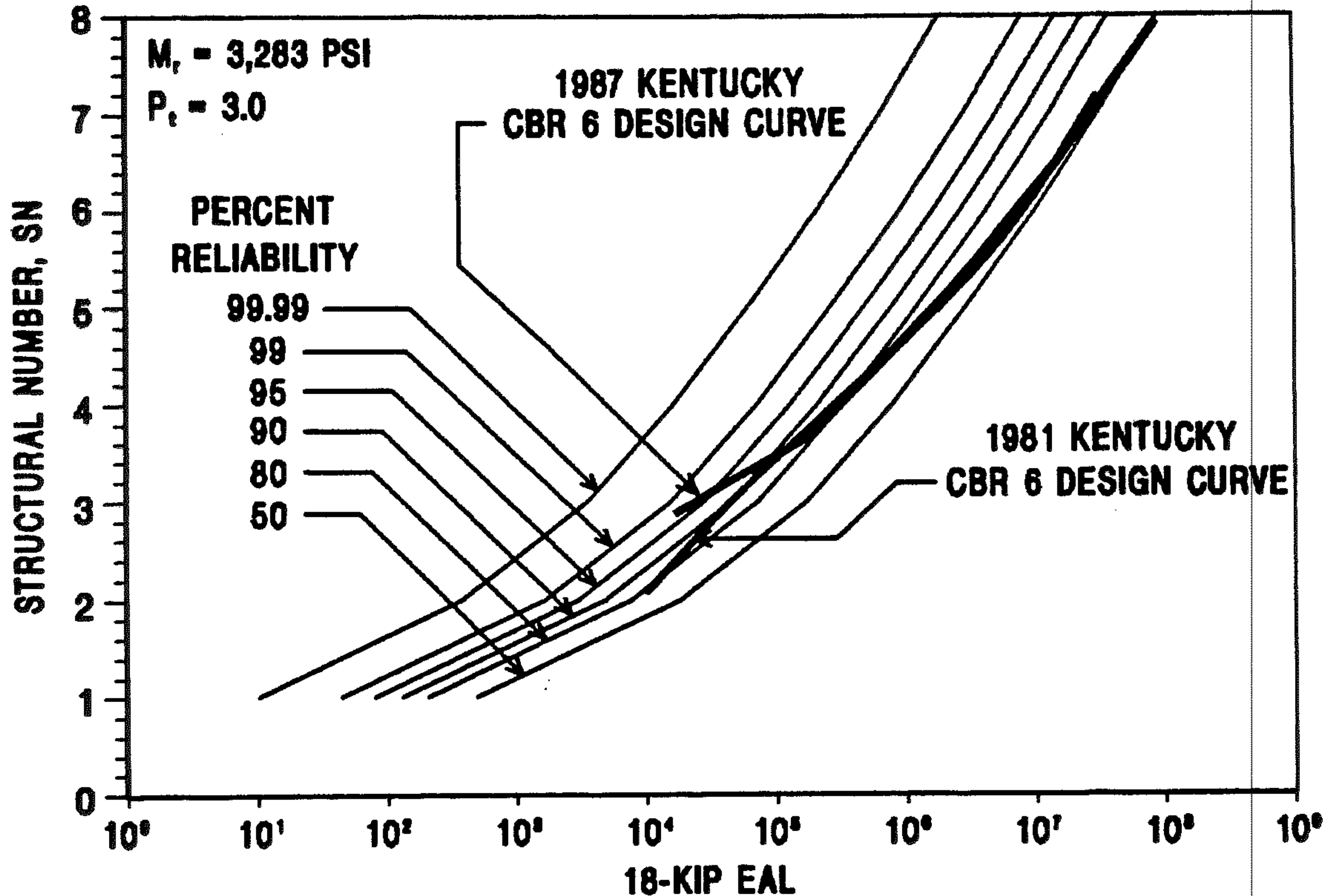


Figure B6. The 1981 and 1987 Kentucky Thickness Design Curve for CBR 6 (M_r of 3,283 psi) Superimposed on a Family of AASHTO Design Curves at Various Reliability Percentages and 3.0 Serviceability Level.

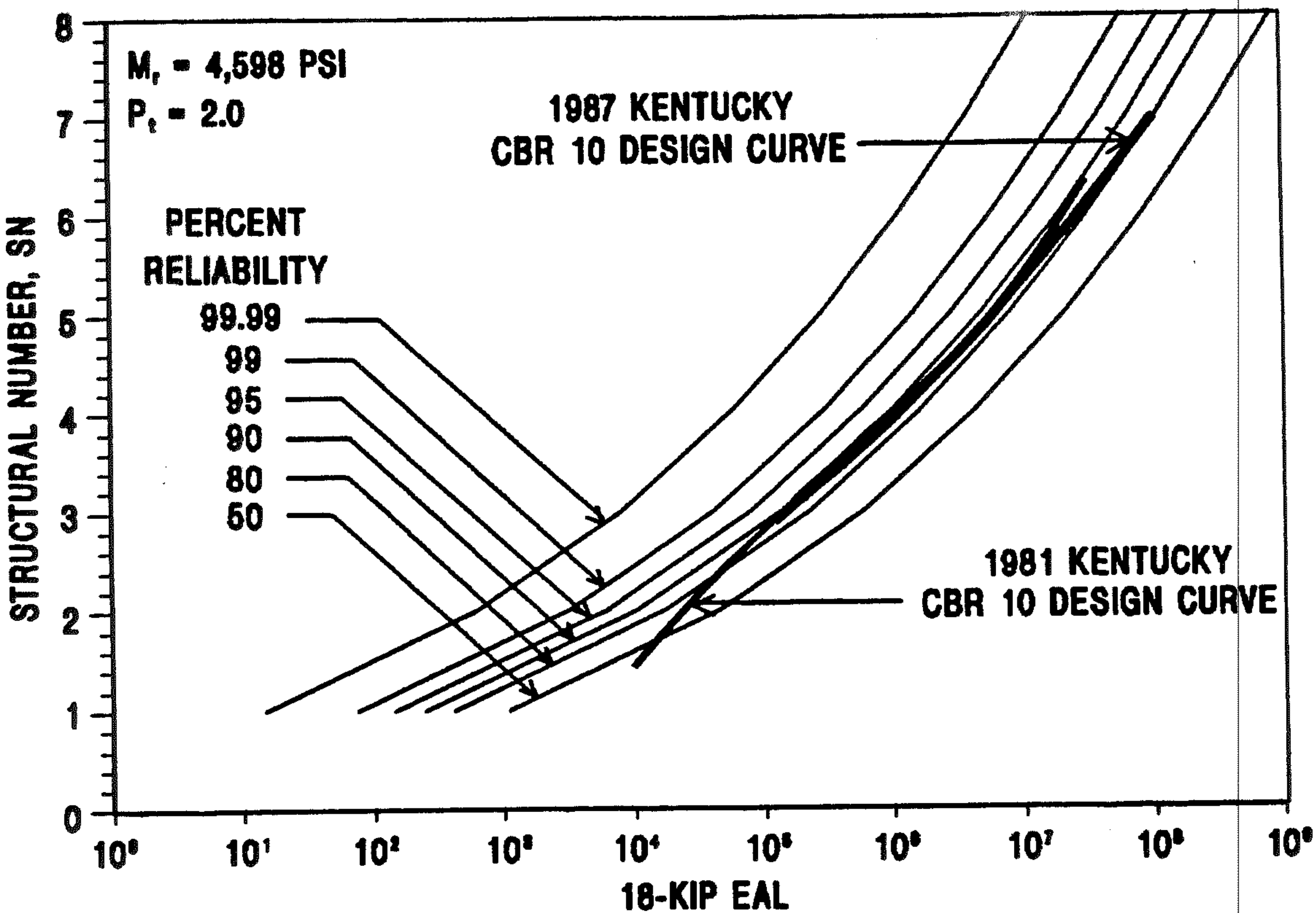


Figure B7. The 1981 and 1987 Kentucky Thickness Design Curve for CBR 10 (M_r of 4,598 psi) Superimposed on a Family of AASHTO Design Curves at Various Reliability Percentages and 2.0 Serviceability Level.

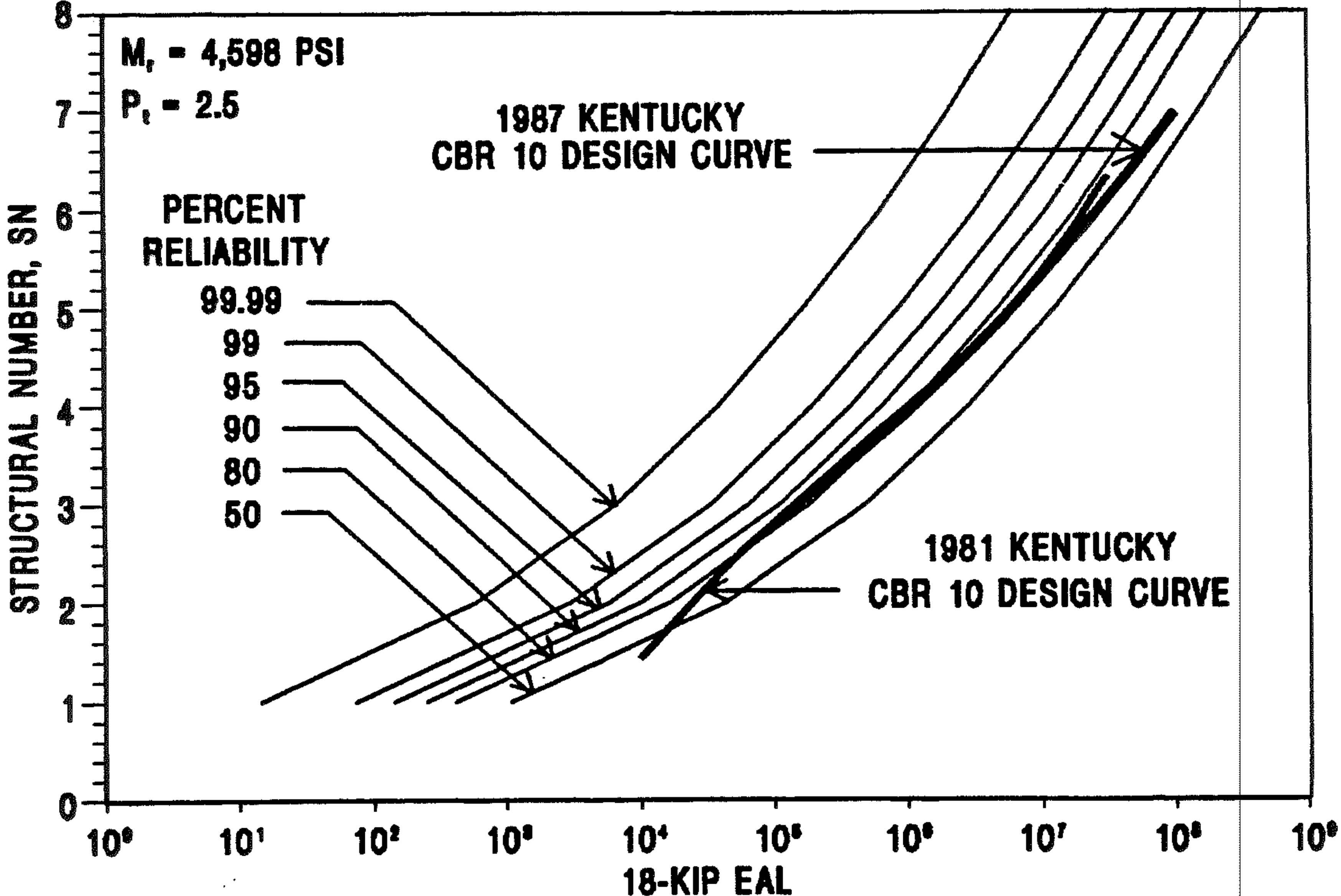


Figure B8. The 1981 and 1987 Kentucky Thickness Design Curve for CBR 10 (M_r of 4,598 psi) Superimposed on a Family of AASHTO Design Curves at Various Reliability Percentages and 2.5 Serviceability Level.

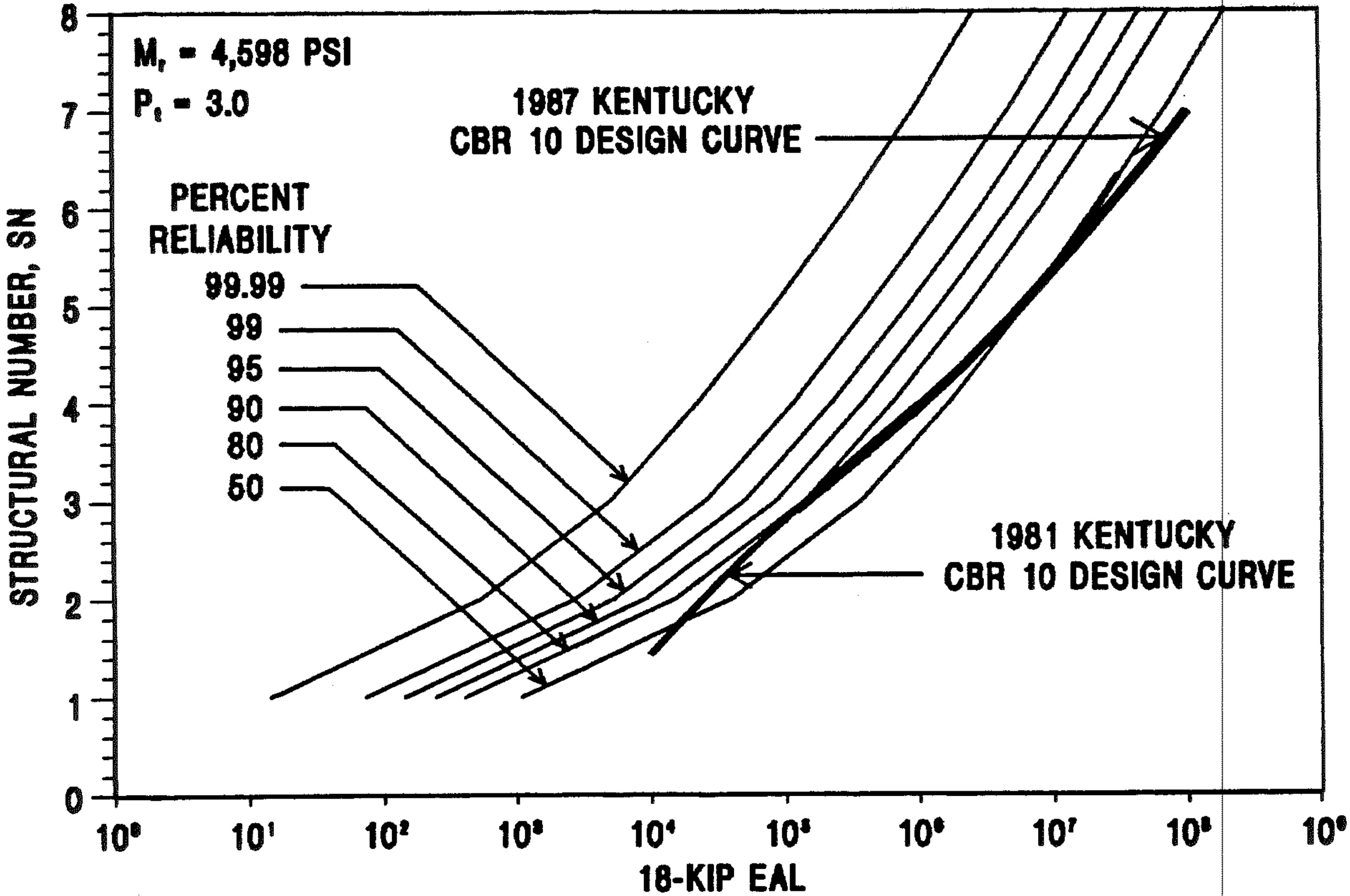


Figure B9. The 1981 and 1987 Kentucky Thickness Design Curve for CBR 10 (M_T of 4,598 psi) Superimposed on a Family of AASHTO Design Curves at Various Reliability Percentages and 3.0 Serviceability Level.

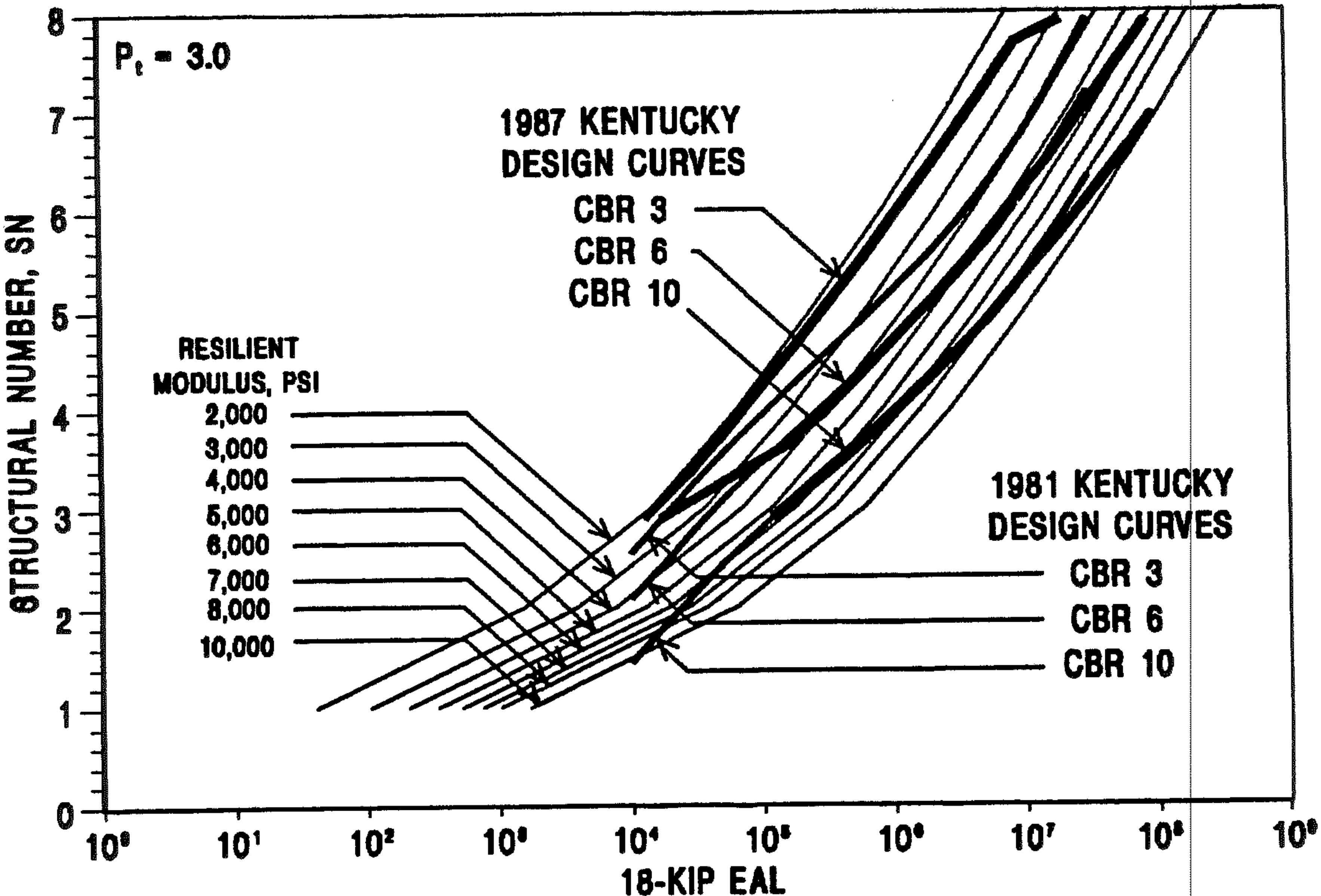


Figure B10. The 1981 and 1987 Kentucky Thickness Design Curve for CBR 3 Superimposed on a Family of Resilient Modulus Curves from 1986 AASHTO Design Equation for 3.0 Serviceability Level and 50 Percent Reliability.

APPENDIX C

1987 KENTUCKY THICKNESS DESIGN CURVES SUPERIMPOSED ON FAMILY OF PERCENT RELIABILITY CURVES BASED ON 1986 AASHTO GUIDE

THIS PAGE LEFT BLANK

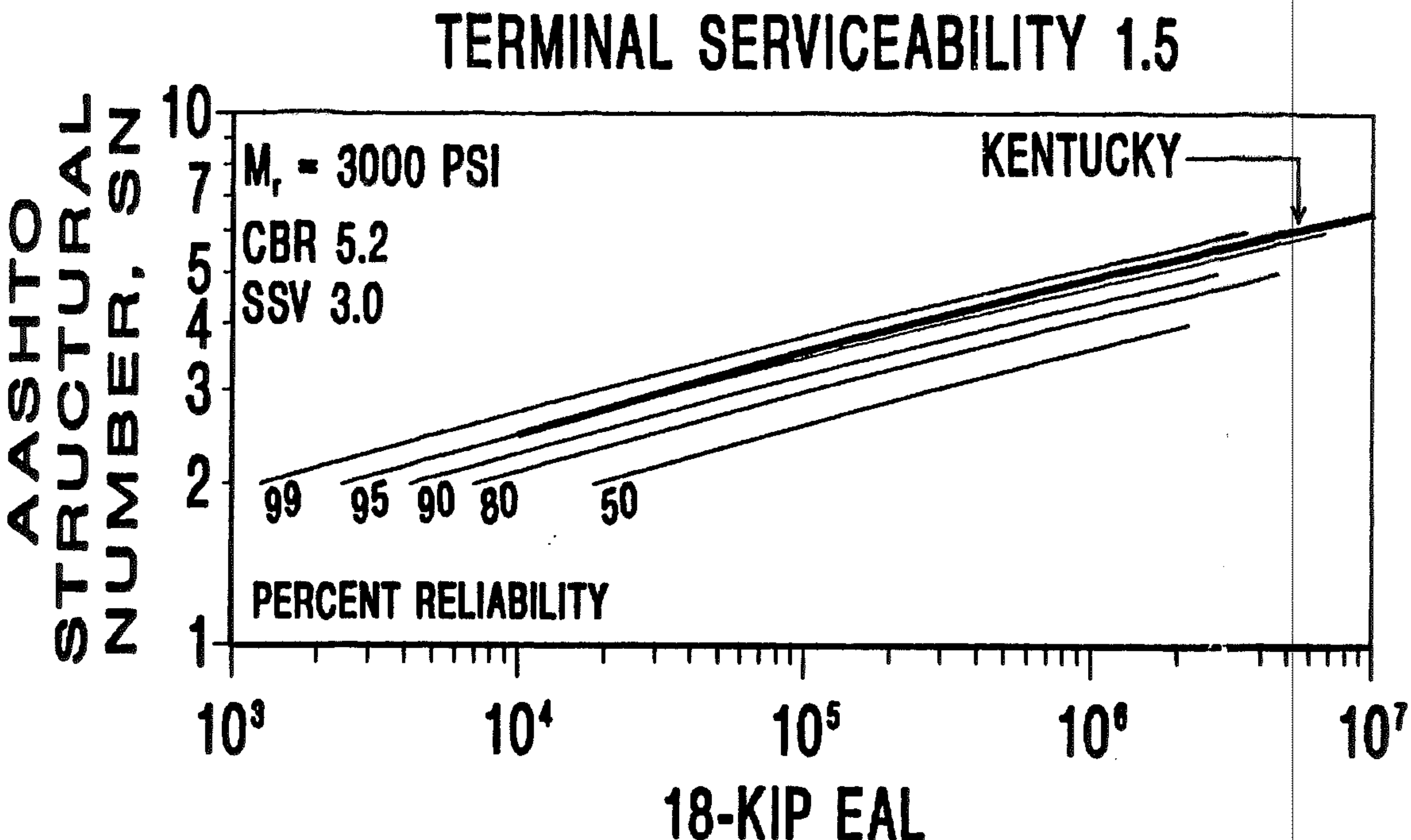


Figure C1. 1987 Kentucky Thickness Design Curve for CBR 5.2 Superimposed on a Family of Percent Reliability Curves from 1986 AASHTO Design Equation at 1.5 Serviceability Level.

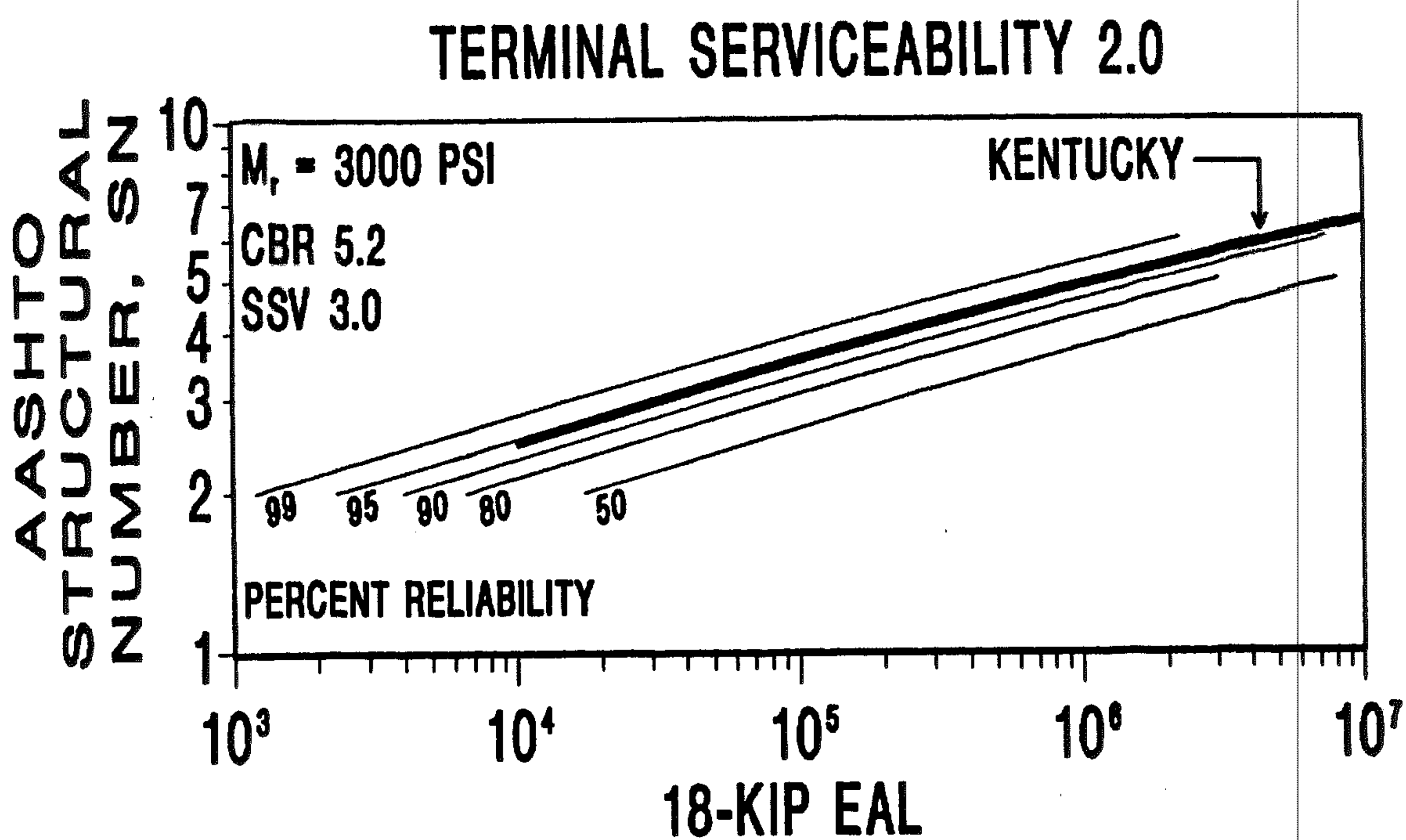


Figure C2. 1987 Kentucky Thickness Design Curve for CBR 5.2 Superimposed on a Family of Percent Reliability Curves from 1986 AASHTO Design Equation at 2.0 Serviceability Level.

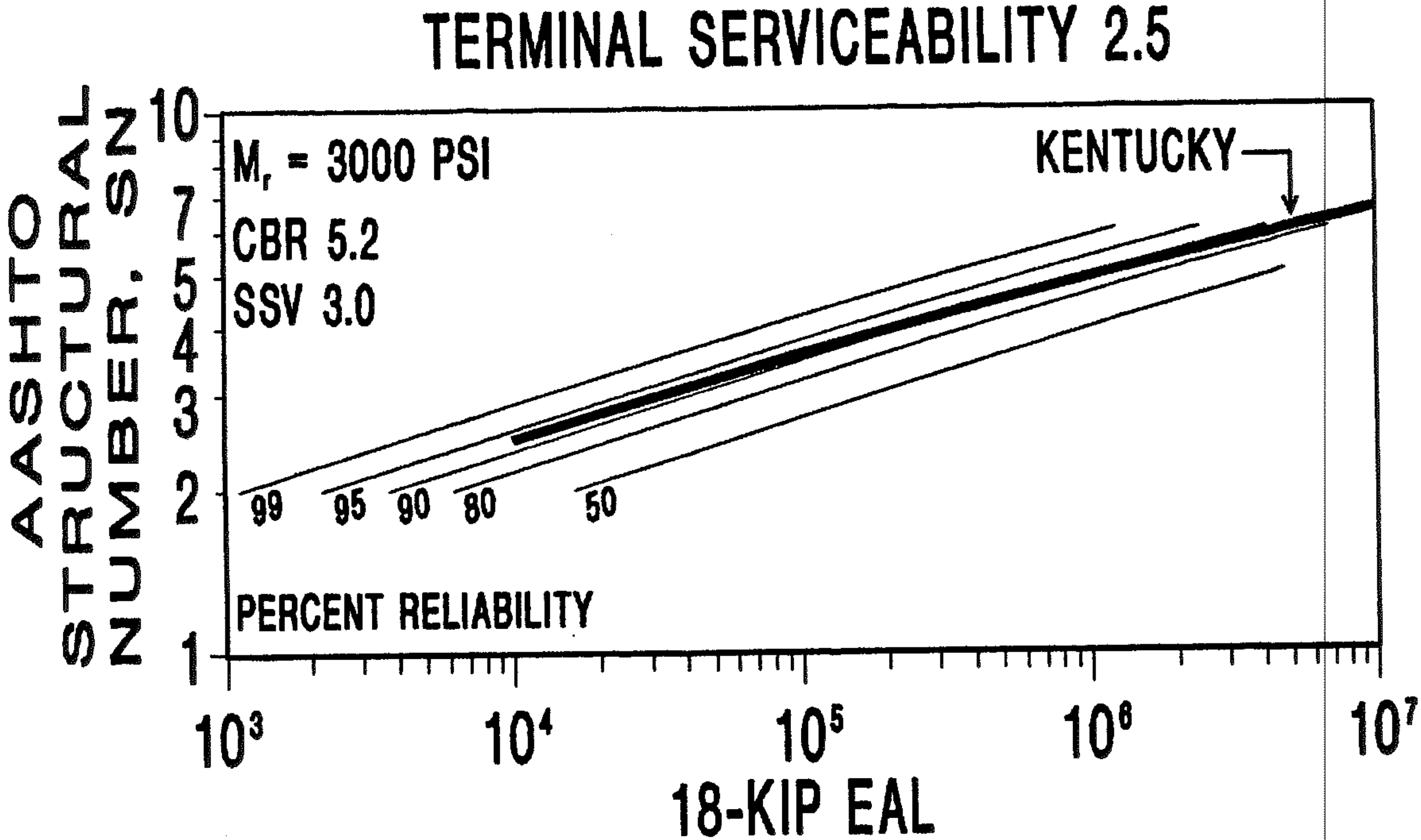


Figure C3. 1987 Kentucky Thickness Design Curve for CBR 5.2 Superimposed on a Family of Percent Reliability Curves from 1986 AASHTO Design Equation at 2.5 Serviceability Level.

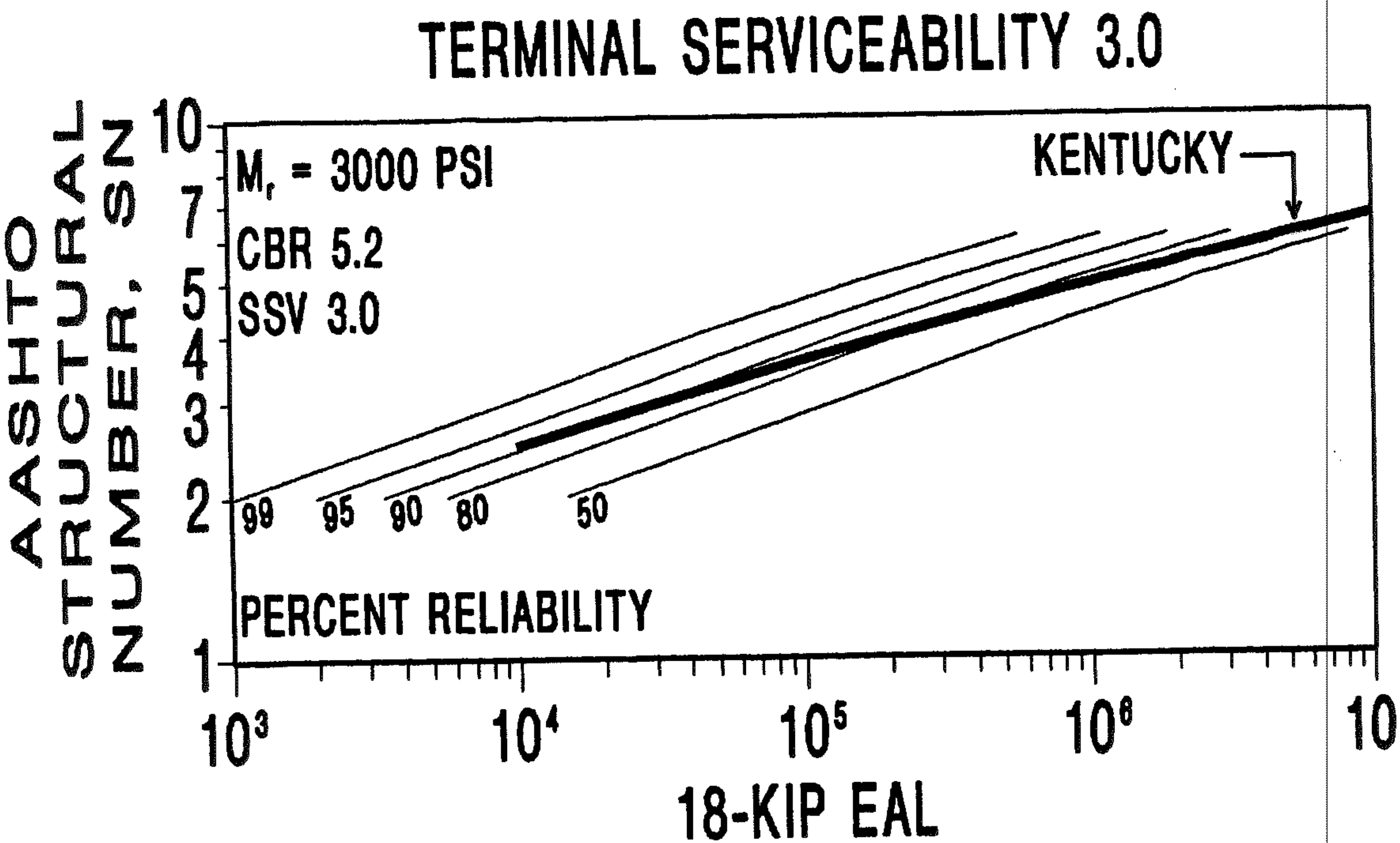


Figure C4. 1987 Kentucky Thickness Design Curve for CBR 5.2 Superimposed on a Family of Percent Reliability Curves from 1986 AASHTO Design Equation at 3.0 Serviceability Level.

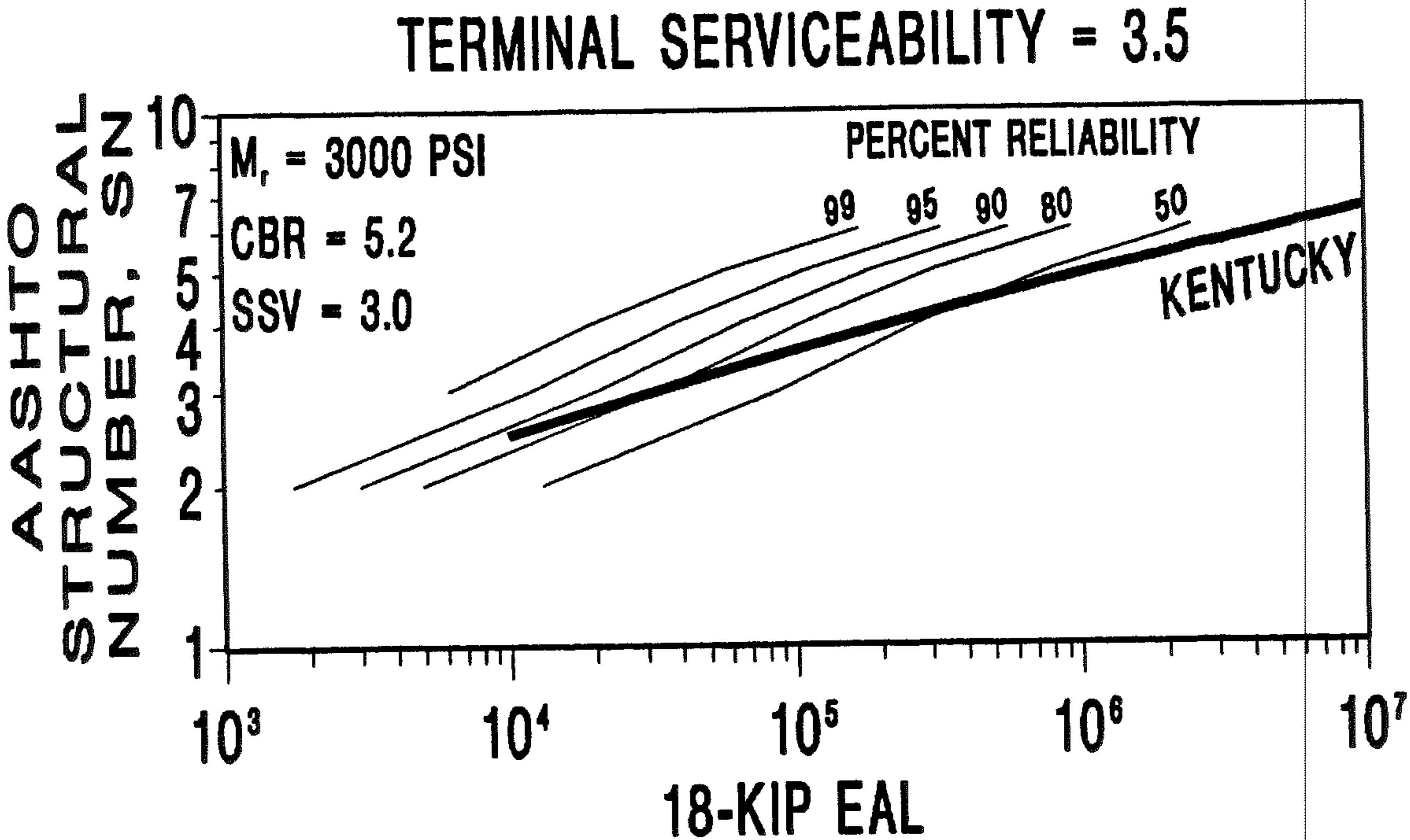


Figure C5. 1987 Kentucky Thickness Design Curve for CBR 5.2 Superimposed on a Family of Percent Reliability Curves from 1986 AASHTO Design Equation at 3.5 Serviceability Level.

THIS PAGE LEFT BLANK

APPENDIX D

1986 AASHTO PERCENT RELIABILITY CURVES AND LOG-LOG STRAIGHT-LINE REGRESSION EQUATION SUPERIMPOSED ON AASHO ROAD TEST DATA PLOTTED AS SN VS 18-KIP EAL

THIS PAGE LEFT BLANK

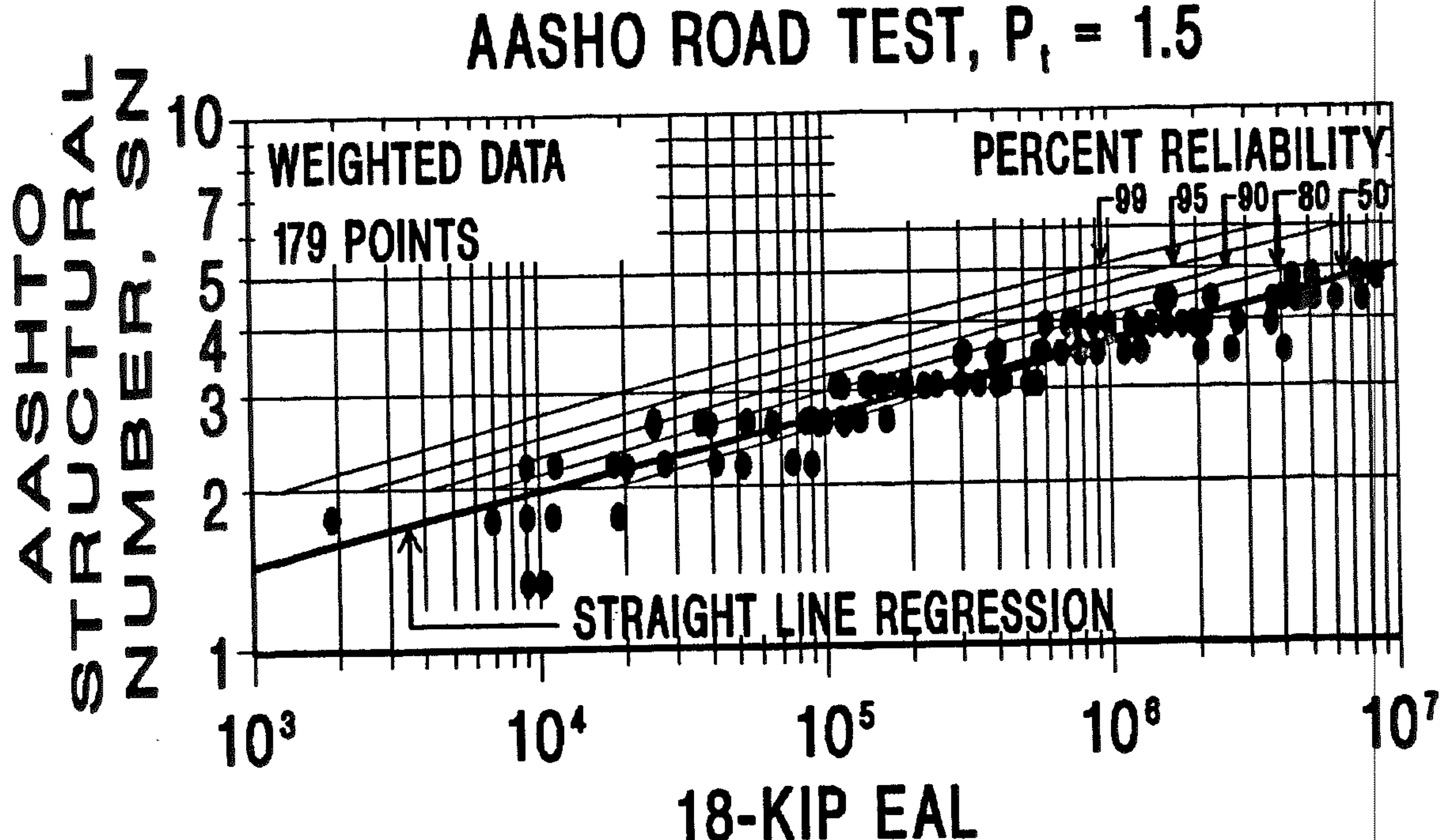


Figure D1. Weighted Fatigue Data from AASHO Road Test (reference 1) with a Log-Log Straight-Line Least-Squares Regression Line and a Family of Percent Reliability Curves from 1986 AASHTO Design Equation at 1.5 Serviceability Level.

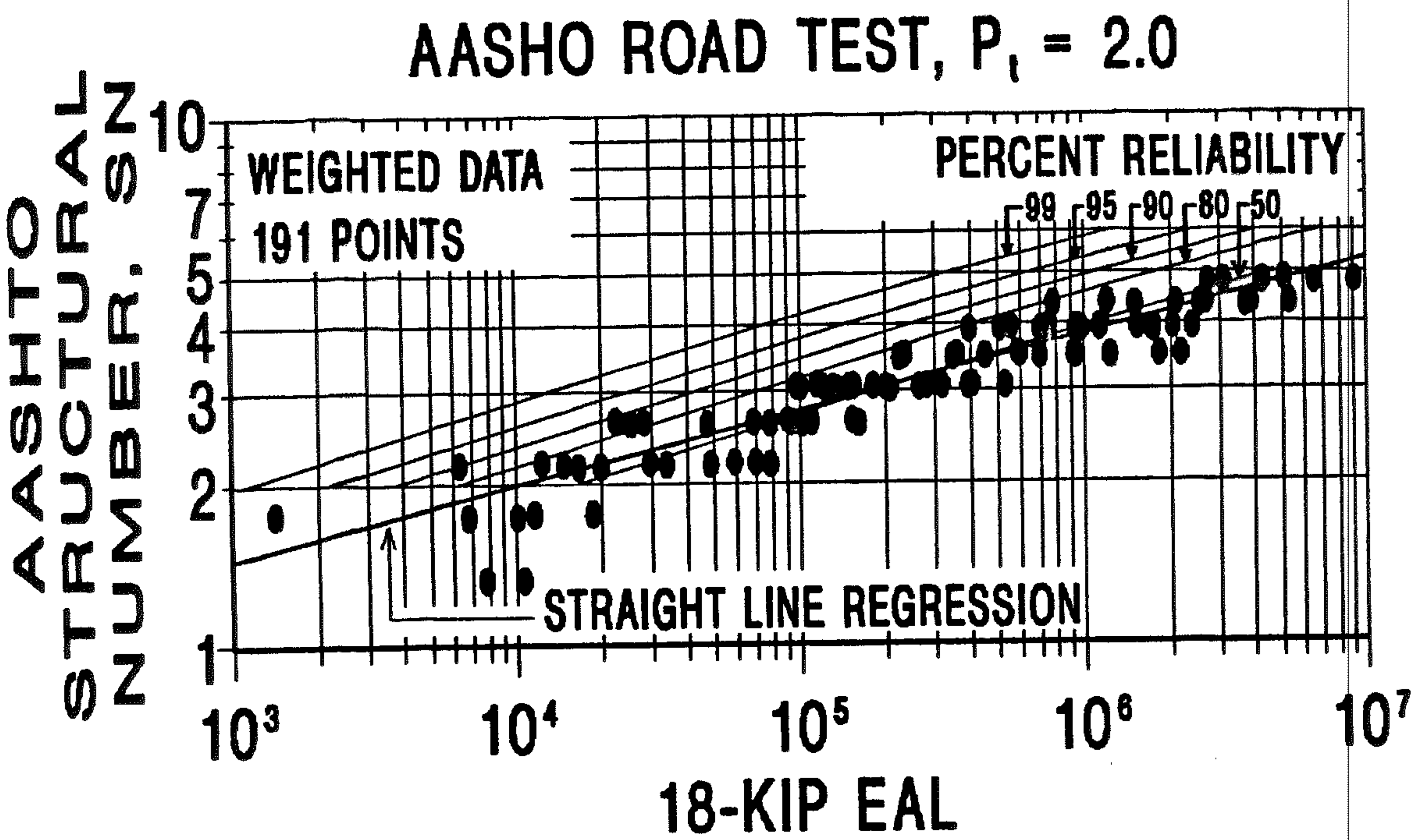


Figure D2. Weighted Fatigue Data from AASHO Road Test (reference 1) with a Log-Log Straight-Line Least-Squares Regression Line and a Family of Percent Reliability Curves from 1986 AASHTO Design Equation at 2.0 Serviceability Level.

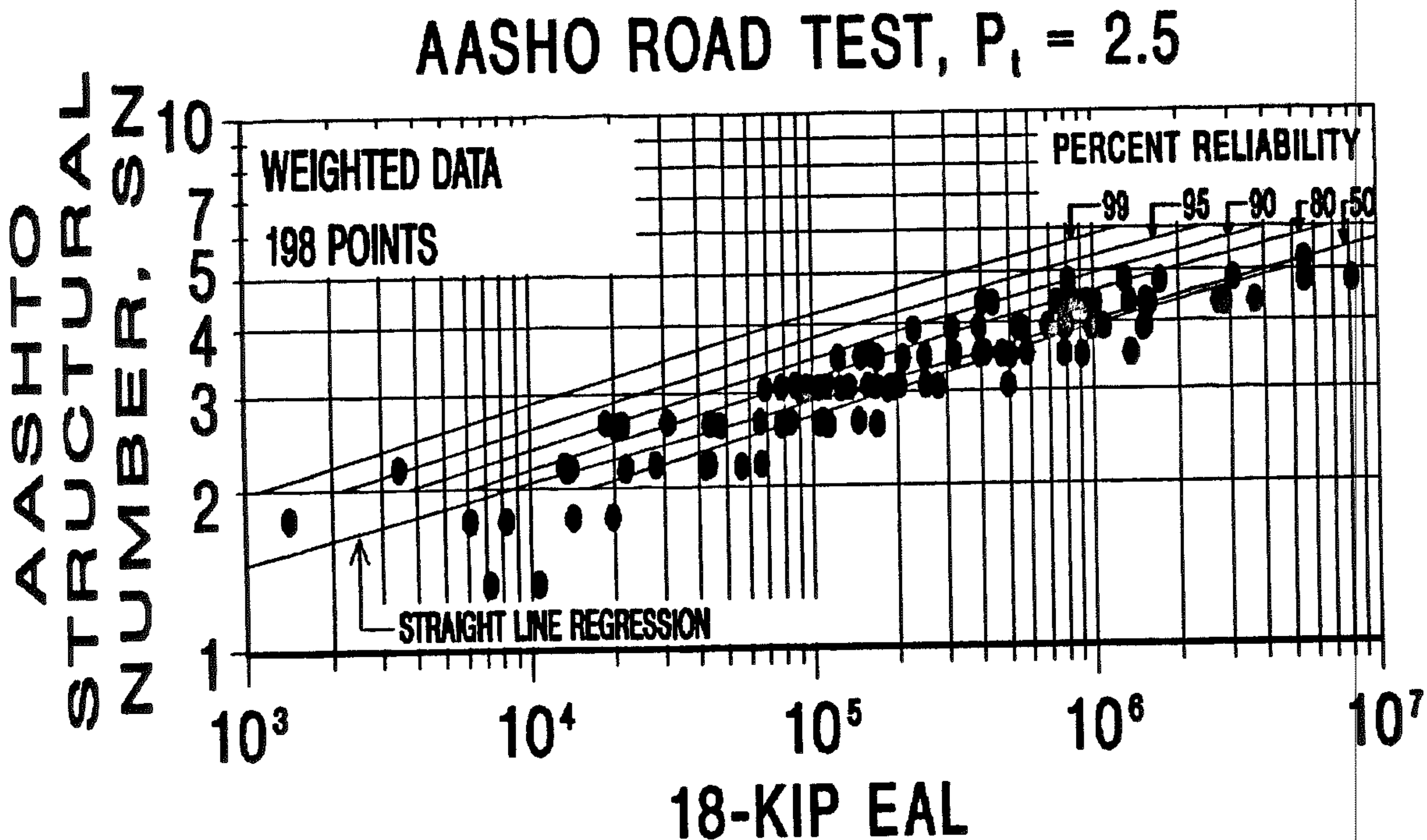


Figure D3. Weighted Fatigue Data from AASHO Road Test (reference 1) with a Log-Log Straight-Line Least-Squares Regression Line and a Family of Percent Reliability Curves from 1986 AASHTO Design Equation at 2.5 Serviceability Level.

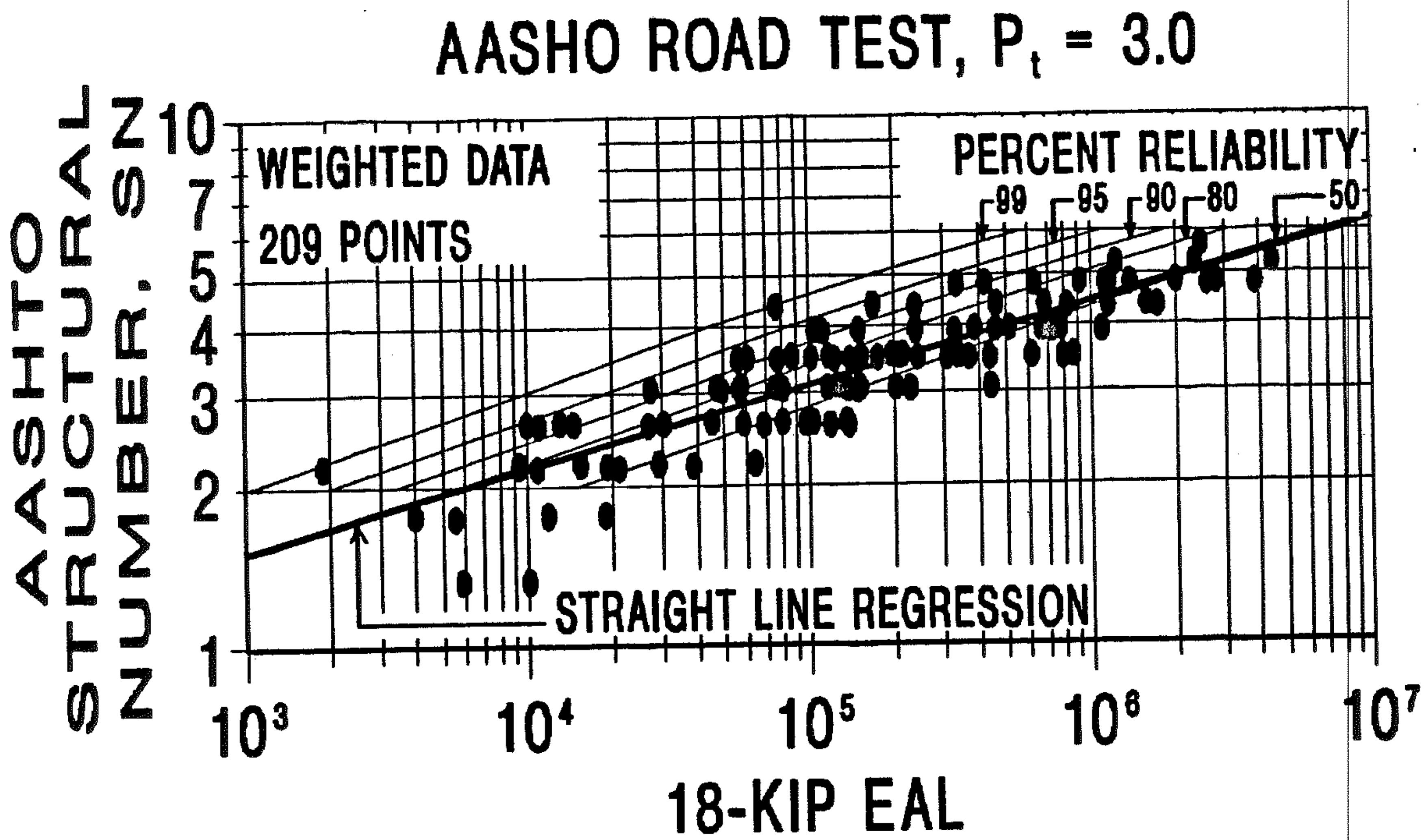


Figure D4. Weighted Fatigue Data from AASHO Road Test (reference 1) with a Log-Log Straight-Line Least-Squares Regression Line and a Family of Percent Reliability Curves from 1986 AASHTO Design Equation at 3.0 Serviceability Level.

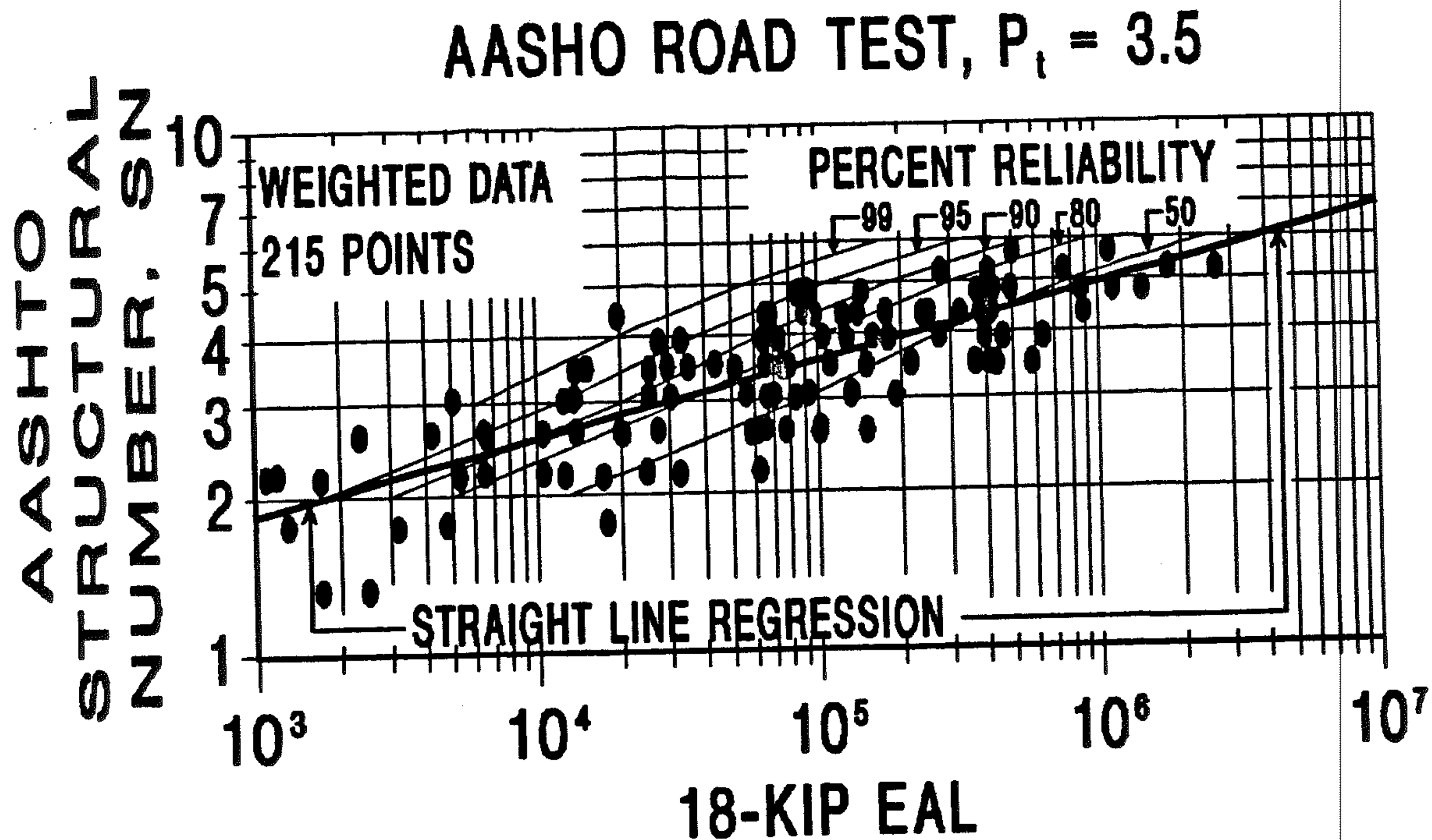


Figure D5. Weighted Fatigue Data from AASHO Road Test (reference 1) with a Log-Log Straight-Line Least-Squares Regression Line and a Family of Percent Reliability Curves from 1986 AASHTO Design Equation at 3.5 Serviceability Level.

THIS PAGE LEFT BLANK

APPENDIX E

COMPARISON OF AC PAVEMENT THICKNESS DESIGNS FOR 1981 KENTUCKY, 1987 KENTUCKY, AND 1986 AASHTO METHODS

THIS PAGE LEFT BLANK

METHOD USED TO CONVERT AASHTO SN TO THICKNESS

CRITERIA

LAYER	MATERIAL	THICKNESS	a_{1x}	%AC	m
1	AC SURFACE	1.25"	0.44	33	2
2	AC BINDER	1.50"	0.42	50	1
3	AC BASE	2.50" MIN.*	0.40	75	1/3
4	CRUSHED STONE		0.14	100	0

NOTE: IF (AC-1.25"), LAYER 3, IS LESS THAN 2.50", USE COEFFICIENT FOR LAYER 2 TO CALCULATE REMAINING AC "BASE" OR "BINDER" THICKNESS.

FOR LAYER 3 >= 2.50":

$$SN = a_{11}d_{11} + a_{12}d_{12} + a_{13}d_{13} + ma_2(d_{11} + d_{12} + d_{13})$$

33% AC THICKNESS, 67% CS THICKNESS:

$$SN = 0.44(1.25) + 0.42(1.50) + 0.40d_{13} + 2(0.14)(1.25 + 1.50 + d_{13})$$
$$= 0.55 + 0.63 + 0.40d_{13} + 0.77 + 0.28d_{13}$$
$$= 1.95 + 0.68d_{13}$$

THUS, $d_{13} = (SN - 1.95) / 0.68$

50% AC THICKNESS, 50% CS THICKNESS:

$$SN = 0.44(1.25) + 0.42(1.50) + 0.40d_{13} + 1(0.14)(1.25 + 1.50 + d_{13})$$
$$= 0.55 + 0.63 + 0.40d_{13} + 0.385 + 0.14d_{13}$$
$$= 1.565 + 0.54d_{13}$$

THUS, $d_{13} = (SN - 1.565) / 0.54$

75% AC THICKNESS, 25% CS THICKNESS:

$$SN = 0.44(1.25) + 0.42(1.50) + 0.40d_{13} + (0.14/3)(1.25 + 1.50 + d_{13})$$
$$= 0.55 + 0.63 + 0.40d_{13} + 0.128 + 0.047d_{13}$$

THUS, $d_{13} = (SN - 1.308) / 0.447$

100% AC THICKNESS, 0% CS THICKNESS:

$$SN = 0.44(1.25) + 0.42(1.50) + 0.40(d_{13})$$
$$= 1.18 + 0.40d_{13}$$

Thus, $d_{13} = (SN - 1.18) / 0.40$

4" CS THICKNESS:

$$SN = 0.44(1.25) + 0.42(1.50) + 0.40d_{13} + 0.14(4.00)$$
$$= 0.55 + 0.63 + 0.56 + 0.40d_{13}$$
$$= 1.74 + 0.40d_{13}$$

THUS, $d_{13} = (SN - 1.74) / 0.40$

FIGURE E1. THICKNESS DESIGNS FOR 33% AC, 67% CS, CBR 2 AND CBR 3.

CBR = 2 Mr = 1591 %REL = 90	AC=33%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	18.99	19.66	4.08	17.65	4.32	18.71	4.35	18.84	4.62	20.03	4.80	20.82	5.12	22.24
250,000	21.26	23.08	4.64	20.12	4.91	21.31	4.98	21.62	5.27	22.90	5.53	24.04	5.86	25.50
500,000	23.09	25.70	5.10	22.15	5.38	23.38	5.48	23.82	5.80	25.24	6.10	26.56	6.44	28.06
750,000	24.20	27.24	5.38	23.38	5.67	24.66	5.80	25.24	6.12	26.65	6.44	28.06	6.80	29.65
1,000,000	25.01	28.33	5.59	24.31	5.89	25.63	6.02	26.21	6.35	27.66	6.69	29.16	7.06	30.79
2,500,000	27.70	31.86	6.28	27.35	6.61	28.81	6.78	29.56	7.14	31.15	7.53	32.87	7.92	34.59
5,000,000	29.85	34.54	6.86	29.91	7.21	31.46	7.40	32.29	7.78	33.97	8.21	35.87	8.63	37.72
7,500,000	31.16	36.13	7.21	31.46	7.58	33.09	7.78	33.97	8.18	35.74	8.63	37.72	9.07	39.66
10,000,000	32.10	37.26	7.47	32.60	7.85	34.28	8.06	35.21	8.47	37.01	8.94	39.09	9.39	41.07
15,000,000	33.46	38.85	7.85	34.28	8.24	36.00	8.47	37.01	8.89	38.87	9.39	41.07	9.85	43.10
20,000,000	34.45	39.99	8.12	35.47	8.53	37.28	8.77	38.34	9.20	40.24	9.72	42.53	10.20	44.65
25,000,000	35.22	40.87	8.35	36.49	8.76	38.29	9.00	39.35	9.45	41.34	9.98	43.68	10.47	45.84
30,000,000	35.86	41.60	8.53	37.28	8.96	39.18	9.20	40.24	9.66	42.26	10.20	44.65	10.70	46.85
35,000,000	36.41	42.21	8.69	37.99	9.12	39.88	9.37	40.99	9.84	43.06	10.38	45.44	10.89	47.69
40,000,000	36.89	42.74	8.83	38.60	9.27	40.54	9.52	41.65	10.00	43.76	10.55	46.19	11.07	48.49
45,000,000	37.31	43.21	8.96	39.18	9.40	41.12	9.66	42.26	10.13	44.34	10.70	46.85	11.22	49.15
50,000,000	37.70	43.64	9.07	39.66	9.52	41.65	9.78	42.79	10.26	44.91	10.83	47.43	11.36	49.76
75,000,000	39.19	45.26	9.52	41.65	9.98	43.68	10.26	44.91	10.76	47.12	11.36	49.76	11.91	52.19
100,000,000	40.27	46.42	9.85	43.10	10.33	45.22	10.62	46.50	11.13	48.75	11.75	51.49	12.31	53.96

CBR = 3 Mr = 2092 %REL = 90	AC=33%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	17.49	17.55	3.73	16.10	3.96	17.12	3.95	17.07	4.21	18.22	4.33	18.04	4.64	18.75
250,000	19.76	20.31	4.26	18.44	4.51	19.54	4.55	19.72	4.83	20.96	5.03	20.96	5.35	21.84
500,000	21.52	22.46	4.69	20.34	4.95	21.49	5.03	21.84	5.32	23.12	5.59	23.29	5.92	24.31
750,000	22.57	23.75	4.95	21.49	5.23	22.72	5.32	23.12	5.63	24.49	5.92	24.67	6.26	25.76
1,000,000	23.33	24.68	5.15	22.37	5.43	23.60	5.54	24.09	5.85	25.46	6.16	25.67	6.50	26.82
2,500,000	25.78	27.70	5.81	25.28	6.11	26.60	6.26	27.26	6.60	28.76	6.96	29.00	7.33	30.35
5,000,000	27.69	30.05	6.34	27.62	6.67	29.07	6.84	29.82	7.20	31.41	7.60	31.67	8.00	33.18
7,500,000	28.82	31.46	6.67	29.07	7.02	30.62	7.20	31.41	7.58	33.09	8.00	33.33	8.41	34.94
10,000,000	29.63	32.47	6.92	30.18	7.27	31.72	7.47	32.60	7.85	34.28	8.29	34.54	8.71	36.22
15,000,000	30.79	33.91	7.27	31.72	7.64	33.35	7.85	34.28	8.25	36.04	8.71	36.29	9.15	38.07
20,000,000	31.62	34.95	7.53	32.87	7.92	34.59	8.13	35.51	8.54	37.32	9.02	37.58	9.47	39.44
25,000,000	32.27	35.76	7.74	33.79	8.13	35.51	8.35	36.49	8.77	38.34	9.26	38.58	9.73	40.50
30,000,000	32.81	36.43	7.92	34.59	8.31	36.31	8.54	37.32	8.97	39.22	9.47	39.46	9.94	41.43
35,000,000	33.26	37.00	8.06	35.21	8.47	37.01	8.70	38.03	9.14	39.97	9.65	40.21	10.12	42.22
40,000,000	33.65	37.49	8.20	35.82	8.61	37.63	8.84	38.65	9.28	40.59	9.80	40.83	10.28	42.88
45,000,000	34.00	37.93	8.31	36.31	8.73	38.16	8.97	39.22	9.41	41.16	9.94	41.42	10.43	43.50
50,000,000	34.32	38.32	8.42	36.79	8.84	38.65	9.08	39.71	9.53	41.69	10.06	41.92	10.56	44.03
75,000,000	35.53	39.84	8.84	38.65	9.28	40.59	9.53	41.69	10.00	43.76	10.56	44.00	11.08	46.24
100,000,000	36.40	40.94	9.15	40.01	9.60	42.00	9.87	43.19	10.35	45.31	10.92	45.50	11.45	47.82

FIGURE E2. THICKNESS DESIGNS FOR 33% AC, 67% CS, CBR 4 AND CBR 5.

CBR = 4 Mr = 2513 %REL = 90	AC=33%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	15.87	16.10	3.50	15.09	3.72	16.06	3.68	15.88	3.93	16.99	4.00	17.29	4.31	18.66
250,000	18.06	18.45	4.00	17.29	4.24	18.35	4.25	18.40	4.52	19.59	4.69	20.34	5.01	21.75
500,000	19.85	20.33	4.41	19.10	4.67	20.25	4.72	20.47	5.01	21.75	5.23	22.72	5.56	24.18
750,000	20.94	21.46	4.67	20.25	4.93	21.40	5.01	21.75	5.30	23.03	5.56	24.18	5.89	25.63
1,000,000	21.73	22.29	4.85	21.04	5.13	22.28	5.21	22.63	5.51	23.96	5.79	25.19	6.13	26.69
2,500,000	24.39	25.02	5.48	23.82	5.78	25.15	5.91	25.72	6.23	27.13	6.57	28.63	6.93	30.22
5,000,000	26.52	27.18	6.00	26.12	6.31	27.49	6.47	28.19	6.81	29.69	7.19	31.37	7.57	33.04
7,500,000	27.82	28.49	6.31	27.49	6.65	28.99	6.81	29.69	7.17	31.28	7.57	33.04	7.96	34.76
10,000,000	28.76	29.43	6.55	28.54	6.89	30.04	7.07	30.84	7.43	32.43	7.85	34.28	8.25	36.04
15,000,000	30.12	30.79	6.89	30.04	7.24	31.59	7.43	32.43	7.82	34.15	8.25	36.04	8.67	37.90
20,000,000	31.10	31.77	7.14	31.15	7.50	32.74	7.70	33.62	8.10	35.38	8.55	37.37	8.98	39.26
25,000,000	31.88	32.54	7.34	32.03	7.71	33.66	7.92	34.59	8.21	35.87	8.78	38.38	9.22	40.32
30,000,000	32.52	33.17	7.50	32.74	7.88	34.41	8.10	35.38	8.51	37.19	8.98	39.26	9.43	41.25
35,000,000	33.07	33.72	7.64	33.35	8.03	35.07	8.25	36.04	8.67	37.90	9.15	40.01	9.61	42.04
40,000,000	33.55	34.19	7.77	33.93	8.16	35.65	8.39	36.66	8.81	38.51	9.30	40.68	9.76	42.71
45,000,000	33.98	34.61	7.88	34.41	8.28	36.18	8.51	37.19	8.93	39.04	9.43	41.25	9.90	43.32
50,000,000	34.36	34.99	7.98	34.85	8.38	36.62	8.61	37.63	9.05	39.57	9.55	41.78	10.02	43.85
75,000,000	35.86	36.46	8.38	36.62	8.80	38.47	9.05	39.57	9.50	41.56	10.02	43.85	10.52	46.06
100,000,000	36.95	37.53	8.68	37.94	9.11	39.84	9.36	40.94	9.82	42.97	10.37	45.40	10.88	47.65

CBR = 5 Mr = 2911 %REL = 90	AC=33%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	14.85	14.97	3.33	14.34	3.53	15.22	3.48	15.00	3.72	16.06	3.76	16.24	4.05	17.51
250,000	17.00	17.09	3.81	16.46	4.04	17.47	4.03	17.43	4.30	18.62	4.43	19.19	4.74	20.56
500,000	18.73	18.81	4.21	18.22	4.45	19.28	4.49	19.46	4.76	20.65	4.97	21.57	5.29	22.99
750,000	19.78	19.86	4.45	19.28	4.71	20.43	4.76	20.65	5.05	21.93	5.29	22.99	5.61	24.40
1,000,000	20.55	20.63	4.63	20.07	4.90	21.26	4.97	21.57	5.26	22.85	5.52	24.00	5.85	25.46
2,500,000	23.11	23.17	5.24	22.76	5.53	24.04	5.64	24.53	5.96	25.94	6.27	27.31	6.62	28.85
5,000,000	25.15	25.21	5.74	24.97	6.05	26.34	6.19	26.96	6.52	28.41	6.88	30.00	7.25	31.63
7,500,000	26.39	26.45	6.05	26.34	6.37	27.75	6.52	28.41	6.87	29.96	7.25	31.63	7.63	33.31
10,000,000	27.29	27.35	6.27	27.31	6.60	28.76	6.77	29.51	7.12	31.06	7.52	32.82	7.91	34.54
15,000,000	28.59	28.64	6.60	28.76	6.94	30.26	7.12	31.06	7.49	32.69	7.91	34.54	8.32	36.35
20,000,000	29.52	29.58	6.84	29.82	7.19	31.37	7.38	32.21	7.76	33.88	8.20	35.82	8.61	37.63
25,000,000	30.26	30.32	7.03	30.66	7.39	32.25	7.59	33.13	7.98	34.85	8.42	36.79	8.85	38.69
30,000,000	30.87	30.93	7.19	31.37	7.56	33.00	7.76	33.88	8.16	35.65	8.61	37.63	9.05	39.57
35,000,000	31.39	31.45	7.33	31.99	7.71	33.66	7.91	34.54	8.31	36.31	8.78	38.38	9.22	40.32
40,000,000	31.85	31.90	7.45	32.51	7.83	34.19	8.04	35.12	8.45	36.93	8.92	39.00	9.37	40.99
45,000,000	32.25	32.31	7.56	33.00	7.94	34.68	8.16	35.65	8.57	37.46	9.05	39.57	9.50	41.56
50,000,000	32.62	32.67	7.66	33.44	8.05	35.16	8.27	36.13	8.68	37.94	9.17	40.10	9.62	42.09
75,000,000	34.04	34.10	8.05	35.16	8.45	36.93	8.68	37.94	9.12	39.88	9.62	42.09	10.10	44.21
100,000,000	35.07	35.13	8.33	36.40	8.75	38.25	8.99	39.31	9.43	41.25	9.96	43.59	10.45	45.75

FIGURE E3. THICKNESS DESIGNS FOR 33% AC, 67% CS, CBR 6 AND CBR 7.

CBR = 6 Mr = 3283 %REL = 90	AC=33%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	13.87	14.09	3.19	13.72	3.39	14.60	3.32	14.29	3.55	15.31	3.57	15.40	3.85	16.63
250,000	15.98	16.06	3.66	15.79	3.88	16.76	3.86	16.68	4.11	17.78	4.22	18.26	4.53	19.63
500,000	17.66	17.66	4.04	17.47	4.28	18.53	4.30	18.62	4.57	19.81	4.75	20.60	5.07	22.01
750,000	18.68	18.65	4.28	18.53	4.53	19.63	4.57	19.81	4.85	21.04	5.07	22.01	5.39	23.43
1,000,000	19.42	19.37	4.46	19.32	4.71	20.43	4.77	20.69	5.06	21.97	5.29	22.99	5.62	24.44
2,500,000	21.87	21.79	5.05	21.93	5.33	23.16	5.43	23.60	5.74	24.97	6.04	26.29	6.38	27.79
5,000,000	23.81	23.74	5.54	24.09	5.83	25.37	5.96	25.94	6.29	27.40	6.63	28.90	6.99	30.49
7,500,000	24.98	24.93	5.83	25.37	6.15	26.78	6.29	27.40	6.63	28.90	6.99	30.49	7.36	32.12
10,000,000	25.83	25.79	6.05	26.34	6.37	27.75	6.53	28.46	6.88	30.00	7.25	31.63	7.64	33.35
15,000,000	27.04	27.04	6.37	27.75	6.71	29.25	6.88	30.00	7.24	31.59	7.64	33.35	8.03	35.07
20,000,000	27.92	27.95	6.61	28.81	6.95	30.31	7.13	31.10	7.50	32.74	7.92	34.59	8.33	36.40
25,000,000	28.61	28.66	6.80	29.65	7.15	31.19	7.33	31.99	7.71	33.66	8.14	35.56	8.56	37.41
30,000,000	29.18	29.25	6.95	30.31	7.31	31.90	7.50	32.74	7.89	34.46	8.33	36.40	8.75	38.25
35,000,000	29.67	29.76	7.08	30.88	7.45	32.51	7.65	33.40	8.04	35.12	8.48	37.06	8.92	39.00
40,000,000	30.09	30.20	7.20	31.41	7.57	33.04	7.77	33.93	8.17	35.69	8.62	37.68	9.06	39.62
45,000,000	30.47	30.60	7.31	31.90	7.68	33.53	7.89	34.46	8.29	36.22	8.75	38.25	9.19	40.19
50,000,000	30.81	30.95	7.40	32.29	7.78	33.97	7.99	34.90	8.39	36.66	8.86	38.74	9.31	40.72
75,000,000	32.13	32.34	7.78	33.97	8.17	35.69	8.39	36.66	8.81	38.51	9.31	40.72	9.77	42.75
100,000,000	33.08	33.35	8.05	35.16	8.46	36.97	8.69	37.99	9.13	39.93	9.63	42.13	10.11	44.25

CBR = 7 Mr = 3635 %REL = 90	AC=33%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	13.13	13.36	3.08	13.24	3.27	14.07	3.20	13.76	3.42	14.74	3.41	14.69	3.68	15.88
250,000	15.24	15.22	3.53	15.22	3.75	16.19	3.71	16.01	3.96	17.12	4.05	17.51	4.35	18.84
500,000	16.92	16.75	3.91	16.90	4.14	17.91	4.15	17.96	4.41	19.10	4.57	19.81	4.88	21.18
750,000	17.94	17.70	4.14	17.91	4.38	18.97	4.41	19.10	4.69	20.34	4.88	21.18	5.20	22.59
1,000,000	18.68	18.39	4.31	18.66	4.56	19.76	4.61	19.99	4.89	21.22	5.11	22.19	5.43	23.60
2,500,000	21.11	20.72	4.89	21.22	5.17	22.46	5.26	22.85	5.56	24.18	5.84	25.41	6.18	26.91
5,000,000	23.04	22.60	5.37	23.34	5.66	24.62	5.78	25.15	6.10	26.56	6.43	28.01	6.78	29.56
7,500,000	24.21	23.75	5.66	24.62	5.96	25.94	6.10	26.56	6.43	28.01	6.78	29.56	7.15	31.19
10,000,000	25.05	24.59	5.87	25.54	6.19	26.96	6.33	27.57	6.67	29.07	7.04	30.71	7.41	32.34
15,000,000	26.25	25.80	6.19	26.96	6.51	28.37	6.67	29.07	7.03	30.66	7.41	32.34	7.80	34.06
20,000,000	27.13	26.68	6.41	27.93	6.75	29.43	6.92	30.18	7.28	31.76	7.69	33.57	8.09	35.34
25,000,000	27.81	27.38	6.60	28.76	6.94	30.26	7.12	31.06	7.49	32.69	7.90	34.50	8.31	36.31
30,000,000	28.38	27.96	6.75	29.43	7.10	30.97	7.28	31.76	7.66	33.44	8.09	35.34	8.50	37.15
35,000,000	28.86	28.45	6.88	30.00	7.23	31.54	7.43	32.43	8.05	35.16	8.24	36.00	8.66	37.85
40,000,000	29.28	28.88	6.99	30.49	7.35	32.07	7.55	32.96	7.94	34.68	8.38	36.62	8.80	38.47
45,000,000	29.65	29.27	7.10	30.97	7.46	32.56	7.66	33.44	8.05	35.16	8.50	37.15	8.93	39.04
50,000,000	29.99	29.62	7.19	31.37	7.56	33.00	7.76	33.88	8.16	35.65	8.61	37.63	9.05	39.57
75,000,000	31.29	30.97	7.56	33.00	7.94	34.68	8.16	35.65	8.57	37.46	9.05	39.57	9.50	41.56
100,000,000	32.24	31.96	7.83	34.19	8.22	35.91	8.45	36.93	8.87	38.78	9.36	40.94	9.83	43.01

FIGURE E4. THICKNESS DESIGNS FOR 33% AC, 67% CS, CBR 8 AND CBR 9.

CBR = 8 Mr = 3969 %REL = 90	AC=33%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	*SN*	*INCHES*	SN	INCHES	*SN*	*INCHES*	SN	INCHES	*SN*	*INCHES*
100,000	12.43	12.80	2.99	12.84	*3.17*	*13.63*	3.09	13.28	*3.31*	*14.25*	3.20	13.76	*3.54*	*15.26*
250,000	14.52	14.55	3.43	14.78	*3.64*	*15.71*	3.59	15.49	*3.84*	*16.59*	3.90	16.85	*4.20*	*18.18*
500,000	16.18	16.00	3.79	16.37	*4.02*	*17.38*	4.02	17.38	*4.28*	*18.53*	4.41	19.10	*4.72*	*20.47*
750,000	17.19	16.91	4.02	17.38	*4.26*	*18.44*	4.28	18.53	*4.55*	*19.72*	4.72	20.47	*5.04*	*21.88*
1,000,000	17.92	17.57	4.19	18.13	*4.44*	*19.24*	4.47	19.37	*4.75*	*20.60*	4.95	21.49	*5.27*	*22.90*
2,500,000	20.34	19.82	4.76	20.65	*5.03*	*21.84*	5.11	22.19	*5.41*	*23.51*	5.68	24.71	*6.01*	*26.16*
5,000,000	22.25	21.66	5.22	22.68	*5.51*	*23.96*	5.62	24.44	*5.94*	*25.85*	6.25	27.22	*6.60*	*28.76*
7,500,000	23.40	22.78	5.51	23.96	*5.81*	*25.28*	5.94	25.85	*6.26*	*27.26*	6.60	28.76	*6.96*	*30.35*
10,000,000	24.24	23.61	5.72	24.88	*6.03*	*26.25*	6.17	26.87	*6.50*	*28.32*	6.85	29.87	*7.22*	*31.50*
15,000,000	25.44	24.80	6.03	26.25	*6.35*	*27.66*	6.50	28.32	*6.85*	*29.87*	7.22	31.50	*7.60*	*33.18*
20,000,000	26.30	25.67	6.25	27.22	*6.58*	*28.68*	6.74	29.38	*7.10*	*30.97*	7.49	32.69	*7.88*	*34.41*
25,000,000	26.98	26.36	6.43	28.01	*6.77*	*29.51*	6.94	30.26	*7.30*	*31.85*	7.71	33.66	*8.11*	*35.43*
30,000,000	27.54	26.93	6.58	28.68	*6.92*	*30.18*	7.10	30.97	*7.47*	*32.60*	7.88	34.41	*8.29*	*36.22*
35,000,000	28.02	27.42	6.71	29.25	*7.05*	*30.75*	7.24	31.59	*7.61*	*33.22*	8.04	35.12	*8.45*	*36.93*
40,000,000	28.44	27.85	6.82	29.74	*7.17*	*31.28*	7.36	32.12	*7.74*	*33.79*	8.17	35.69	*8.59*	*37.54*
45,000,000	28.81	28.23	6.92	30.18	*7.28*	*31.76*	7.47	32.60	*7.85*	*34.28*	8.29	36.22	*8.71*	*38.07*
50,000,000	29.15	28.57	7.01	30.57	*7.37*	*32.16*	7.57	33.04	*7.95*	*34.72*	8.40	36.71	*8.83*	*38.60*
75,000,000	30.45	29.92	7.37	32.16	*7.75*	*33.84*	7.95	34.72	*8.36*	*36.53*	8.83	38.60	*9.27*	*40.54*
100,000,000	31.38	30.90	7.64	33.35	*8.02*	*35.03*	8.24	36.00	*8.66*	*37.85*	9.14	39.97	*9.59*	*41.96*

CBR = 9 Mr = 4290 %REL = 90	AC=33%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	*SN*	*INCHES*	SN	INCHES	*SN*	*INCHES*	SN	INCHES	*SN*	*INCHES*
100,000	11.82	12.28	2.90	12.44	*3.09*	*13.28*	3.00	12.88	*3.21*	*13.81*	3.17	13.63	*3.42*	*13.63*
250,000	13.91	14.00	3.34	14.38	*3.54*	*15.26*	3.49	15.04	*3.73*	*16.10*	3.77	16.28	*4.06*	*16.28*
500,000	15.57	15.43	3.70	15.97	*3.92*	*16.94*	3.90	16.85	*4.16*	*18.00*	4.28	18.53	*4.58*	*18.53*
750,000	16.57	16.31	3.92	16.94	*4.15*	*17.96*	4.16	18.00	*4.43*	*19.19*	4.58	19.85	*4.90*	*19.85*
1,000,000	17.29	16.96	4.08	17.65	*4.33*	*18.75*	4.35	18.84	*4.62*	*20.03*	4.81	20.87	*5.12*	*20.87*
2,500,000	19.67	19.15	4.64	20.12	*4.91*	*21.31*	4.98	21.62	*5.27*	*22.90*	5.53	24.04	*5.86*	*24.04*
5,000,000	21.54	20.93	5.10	22.15	*5.38*	*23.38*	5.49	23.87	*5.80*	*25.24*	6.10	26.56	*6.44*	*26.56*
7,500,000	22.67	22.01	5.38	23.38	*5.67*	*24.66*	5.80	25.24	*6.12*	*26.65*	6.44	28.06	*6.80*	*28.06*
10,000,000	23.48	22.81	5.59	24.31	*5.89*	*25.63*	6.02	26.21	*6.35*	*27.66*	6.69	29.16	*7.06*	*29.16*
15,000,000	24.64	23.96	5.89	25.63	*6.20*	*27.00*	6.35	27.66	*6.69*	*29.16*	7.06	30.79	*7.43*	*30.79*
20,000,000	25.48	24.80	6.11	26.60	*6.43*	*28.01*	6.59	28.72	*6.94*	*30.26*	7.32	31.94	*7.71*	*31.94*
25,000,000	26.14	25.47	6.28	27.35	*6.61*	*28.81*	6.78	29.56	*7.14*	*31.15*	7.53	32.87	*7.93*	*32.87*
30,000,000	26.69	26.02	6.43	28.01	*6.77*	*29.51*	6.94	30.26	*7.30*	*31.85*	7.71	33.66	*8.11*	*33.66*
35,000,000	27.15	26.49	6.56	28.59	*6.90*	*30.09*	7.08	30.88	*7.45*	*32.51*	7.86	34.32	*8.26*	*34.32*
40,000,000	27.55	26.90	6.67	29.07	*7.01*	*30.57*	7.20	31.41	*7.57*	*33.04*	7.99	34.90	*8.40*	*34.90*
45,000,000	27.91	27.27	6.77	29.51	*7.12*	*31.06*	7.30	31.85	*7.68*	*33.53*	8.11	35.43	*8.52*	*35.43*
50,000,000	28.23	27.60	6.86	29.91	*7.21*	*31.46*	7.40	32.29	*7.78*	*33.97*	8.21	35.87	*8.63*	*35.87*
75,000,000	29.49	28.90	7.21	31.46	*7.58*	*33.09*	7.78	33.97	*8.18*	*35.74*	8.63	37.72	*9.07*	*37.72*
100,000,000	30.39	29.84	7.47	32.60	*7.85*	*34.28*	8.06	35.21	*8.47*	*37.01*	8.94	39.09	*9.39*	*39.09*

FIGURE E5. THICKNESS DESIGNS FOR 33% AC, 67% CS, CBR 10 AND CBR 11.

CBR = 10 Mr = 4598 %REL = 90	AC=33%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	11.23	11.66	2.83	12.13	3.02	12.97	2.92	12.53	3.12	13.41	3.07	13.19	3.32	14.29
250,000	13.32	13.43	3.26	14.03	3.46	14.91	3.40	14.65	3.63	15.66	3.66	15.79	3.95	17.07
500,000	14.96	14.87	3.61	15.57	3.83	16.54	3.80	16.41	4.06	17.56	4.16	18.00	4.46	19.32
750,000	15.96	15.76	3.83	16.54	4.06	17.56	4.06	17.56	4.32	18.71	4.46	19.32	4.77	20.69
1,000,000	16.67	16.41	3.99	17.25	4.23	18.31	4.24	18.35	4.51	19.54	4.68	20.29	5.00	21.71
2,500,000	19.03	18.58	4.54	19.68	4.80	20.82	4.86	21.09	5.16	22.41	5.40	23.47	5.73	24.93
5,000,000	20.88	20.34	4.99	21.66	5.27	22.90	5.37	23.34	5.67	24.66	5.96	25.94	6.30	27.44
7,500,000	21.99	21.40	5.27	22.90	5.56	24.18	5.67	24.66	5.99	26.07	6.30	27.44	6.66	29.03
10,000,000	22.79	22.18	5.47	23.78	5.77	25.10	5.89	25.63	6.22	27.09	6.55	28.54	6.91	30.13
15,000,000	23.94	23.31	5.77	25.10	6.08	26.47	6.22	27.09	6.55	28.54	6.91	30.13	7.28	31.76
20,000,000	24.77	24.12	5.99	26.07	6.30	27.44	6.46	28.15	6.80	29.65	7.17	31.28	7.55	32.96
25,000,000	25.42	24.77	6.16	26.82	6.48	28.24	6.64	28.94	6.99	30.49	7.38	32.21	7.77	33.93
30,000,000	25.95	25.30	6.30	27.44	6.63	28.90	6.80	29.65	7.16	31.24	7.55	32.96	7.95	34.72
35,000,000	26.41	25.76	6.43	28.01	6.76	29.47	6.93	30.22	7.30	31.85	7.70	33.62	8.10	35.38
40,000,000	26.81	26.16	6.54	28.50	6.87	29.96	7.05	30.75	7.42	32.38	7.83	34.19	8.24	36.00
45,000,000	27.16	26.51	6.63	28.90	6.98	30.44	7.16	31.24	7.53	32.87	7.95	34.72	8.36	36.53
50,000,000	27.48	26.83	6.72	29.29	7.07	30.84	7.25	31.63	7.63	33.31	8.05	35.16	8.46	36.97
75,000,000	28.71	28.08	7.07	30.84	7.43	32.43	7.63	33.31	8.02	35.03	8.46	36.97	8.89	38.87
100,000,000	29.60	28.99	7.32	31.94	7.70	33.62	7.90	34.50	8.30	36.26	8.77	38.34	9.21	40.28

CBR = 11 Mr = 4897 %REL = 90	AC=33%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	10.94	11.27	2.77	11.87	2.95	12.66	2.85	12.22	3.05	13.10	2.99	12.84	3.23	13.90
250,000	12.77	12.98	3.19	13.72	3.39	14.60	3.32	14.29	3.55	15.31	3.56	15.35	3.84	16.59
500,000	14.29	14.38	3.53	15.22	3.75	16.19	3.72	16.06	3.96	17.12	4.05	17.51	4.35	18.84
750,000	15.23	15.24	3.75	16.19	3.98	17.21	3.96	17.12	4.22	18.26	4.35	18.84	4.66	20.21
1,000,000	15.91	15.88	3.91	16.90	4.14	17.91	4.15	17.96	4.41	19.10	4.57	19.81	4.88	21.18
2,500,000	18.23	18.01	4.45	19.28	4.71	20.43	4.76	20.65	5.05	21.93	5.28	22.94	5.61	24.40
5,000,000	20.11	19.73	4.89	21.22	5.17	22.46	5.26	22.85	5.56	24.18	5.84	25.41	6.18	26.91
7,500,000	21.26	20.79	5.17	22.46	5.45	23.69	5.56	24.18	5.87	25.54	6.18	26.91	6.53	28.46
10,000,000	22.10	21.55	5.37	23.34	5.66	24.62	5.78	25.15	6.10	26.56	6.43	28.01	6.78	29.56
15,000,000	23.32	22.66	5.66	24.62	5.96	25.94	6.10	26.56	6.43	28.01	6.78	29.56	7.15	31.19
20,000,000	24.20	23.47	5.87	25.54	6.19	26.96	6.33	27.57	6.67	29.07	7.04	30.71	7.42	32.38
25,000,000	24.90	24.11	6.04	26.29	6.36	27.71	6.52	28.41	6.87	29.96	7.25	31.63	7.63	33.31
30,000,000	25.48	24.64	6.19	26.96	6.51	28.37	6.67	29.07	7.03	30.66	7.42	32.38	7.80	34.06
35,000,000	25.98	25.09	6.31	27.49	6.64	28.94	6.81	29.69	7.17	31.28	7.56	33.00	7.96	34.76
40,000,000	26.41	25.48	6.42	27.97	6.75	29.43	6.92	30.18	7.29	31.81	7.69	33.57	8.09	35.34
45,000,000	26.80	25.83	6.51	28.37	6.85	29.87	7.03	30.66	7.39	32.25	7.80	34.06	8.21	35.87
50,000,000	27.15	26.15	6.60	28.76	6.94	30.26	7.12	31.06	7.49	32.69	7.91	34.54	8.31	36.31
75,000,000	28.51	27.39	6.94	30.26	7.30	31.85	7.49	32.69	7.88	34.41	8.31	36.31	8.74	38.21
100,000,000	29.50	28.29	7.19	31.37	7.56	33.00	7.76	33.88	8.16	35.65	8.61	37.63	9.05	39.57

FIGURE E6. THICKNESS DESIGNS FOR 50% AC, 50% CS, CBR 2 AND CBR 3.

CBR = 2 Mr = 1591 %REL = 90	AC=50%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	14.55	15.13	4.08	14.81	4.32	15.70	4.35	15.81	4.62	16.81	4.80	17.48	5.12	18.67
250,000	16.65	17.80	4.64	16.89	4.91	17.89	4.98	18.15	5.27	19.22	5.53	20.19	5.86	21.41
500,000	18.29	19.82	5.10	18.59	5.38	19.63	5.48	20.00	5.80	21.19	6.10	22.30	6.44	23.56
750,000	19.27	21.01	5.38	19.63	5.67	20.70	5.80	21.19	6.12	22.37	6.44	23.56	6.80	24.89
1,000,000	19.98	21.85	5.59	20.41	5.89	21.52	6.02	22.00	6.35	23.22	6.69	24.48	7.06	25.85
2,500,000	22.28	24.55	6.28	22.96	6.61	24.19	6.78	24.81	7.14	26.15	7.53	27.59	7.92	29.04
5,000,000	24.08	26.60	6.86	25.11	7.21	26.41	7.40	27.11	7.78	28.52	8.21	30.11	8.63	31.67
7,500,000	25.16	27.80	7.21	26.41	7.58	27.78	7.78	28.52	8.18	30.00	8.63	31.67	9.07	33.30
10,000,000	25.93	28.65	7.47	27.37	7.85	28.78	8.06	29.56	8.47	31.07	8.94	32.81	9.39	34.48
15,000,000	27.03	29.86	7.85	28.78	8.24	30.22	8.47	31.07	8.89	32.63	9.39	34.48	9.85	36.19
20,000,000	27.82	30.71	8.12	29.78	8.53	31.30	8.77	32.19	9.20	33.78	9.72	35.70	10.20	37.48
25,000,000	28.44	31.38	8.35	30.63	8.76	32.15	9.00	33.04	9.45	34.70	9.98	36.67	10.47	38.48
30,000,000	28.95	31.92	8.53	31.30	8.96	32.89	9.20	33.78	9.66	35.48	10.20	37.48	10.70	39.33
35,000,000	29.38	32.38	8.69	31.89	9.12	33.48	9.37	34.41	9.84	36.15	10.38	38.15	10.89	40.04
40,000,000	29.76	32.78	8.83	32.41	9.27	34.04	9.52	34.96	10.00	36.74	10.55	38.78	11.07	40.70
45,000,000	30.10	33.14	8.96	32.89	9.40	34.52	9.66	35.48	10.13	37.22	10.70	39.33	11.22	41.26
50,000,000	30.40	33.45	9.07	33.30	9.52	34.96	9.78	35.93	10.26	37.70	10.83	39.81	11.36	41.78
75,000,000	31.56	34.67	9.52	34.96	9.98	36.67	10.26	37.70	10.76	39.56	11.36	41.78	11.91	43.81
100,000,000	32.40	35.53	9.85	36.19	10.33	37.96	10.62	39.04	11.13	40.93	11.75	43.22	12.31	45.30

CBR = 3 Mr = 2092 %REL = 90	AC=50%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	13.21	13.74	3.73	13.52	3.96	14.37	3.95	14.33	4.21	15.30	15.74	14.93	4.64	16.89
250,000	15.18	15.97	4.26	15.48	4.51	16.41	4.55	16.56	4.83	17.59	18.33	17.34	5.35	19.52
500,000	16.72	17.70	4.69	17.07	4.95	18.04	5.03	18.33	5.32	19.41	20.41	19.28	5.92	21.63
750,000	17.64	18.74	4.95	18.04	5.23	19.07	5.32	19.41	5.63	20.56	21.63	20.41	6.26	22.89
1,000,000	18.31	19.48	5.15	18.78	5.43	19.81	5.54	20.22	5.85	21.37	22.52	21.24	6.50	23.78
2,500,000	20.48	21.88	5.81	21.22	6.11	22.33	6.26	22.89	6.60	24.15	25.48	24.00	7.33	26.85
5,000,000	22.18	23.75	6.34	23.19	6.67	24.41	6.84	25.04	7.20	26.37	27.85	26.21	8.00	29.33
7,500,000	23.20	24.86	6.67	24.41	7.02	25.70	7.20	26.37	7.58	27.78	29.33	27.59	8.41	30.85
10,000,000	23.93	25.66	6.92	25.33	7.27	26.63	7.47	27.37	7.85	28.78	30.41	28.59	8.71	31.96
15,000,000	24.98	26.79	7.27	26.63	7.64	28.00	7.85	28.78	8.25	30.26	31.96	30.03	9.15	33.59
20,000,000	25.73	27.60	7.53	27.59	7.92	29.04	8.13	29.81	8.54	31.33	33.11	31.10	9.47	34.78
25,000,000	26.32	28.24	7.74	28.37	8.13	29.81	8.35	30.63	8.77	32.19	34.00	31.93	9.73	35.74
30,000,000	26.81	28.76	7.92	29.04	8.31	30.48	8.54	31.33	8.97	32.93	34.78	32.66	9.94	36.52
35,000,000	27.22	29.21	8.06	29.56	8.47	31.07	8.70	31.93	9.14	33.56	35.44	33.28	10.12	37.19
40,000,000	27.58	29.59	8.20	30.07	8.61	31.59	8.84	32.44	9.28	34.07	36.00	33.79	10.28	37.78
45,000,000	27.90	29.93	8.31	30.48	8.73	32.04	8.97	32.93	9.41	34.56	36.52	34.28	10.43	38.33
50,000,000	28.19	30.24	8.42	30.89	8.84	32.44	9.08	33.33	9.53	35.00	36.96	34.69	10.56	38.81
75,000,000	29.30	31.43	8.84	32.44	9.28	34.07	9.53	35.00	10.00	36.74	38.81	36.41	11.08	40.74
100,000,000	30.10	32.28	9.15	33.59	9.60	35.26	9.87	36.26	10.35	38.04	40.15	37.66	11.45	42.11

FIGURE E7. THICKNESS DESIGNS FOR 50% AC, 50% CS, CBR 4 AND CBR 5.

CBR = 4 Mr = 2513 %REL = 90	AC=50%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	12.02	12.79	3.50	12.67	3.72	13.48	3.68	13.33	3.93	14.26	4.00	14.52	4.31	15.67
250,000	13.92	14.75	4.00	14.52	4.24	15.41	4.25	15.44	4.52	16.44	4.69	17.07	5.01	18.26
500,000	15.47	16.30	4.41	16.04	4.67	17.00	4.72	17.19	5.01	18.26	5.23	19.07	5.56	20.30
750,000	16.41	17.24	4.67	17.00	4.93	17.96	5.01	18.26	5.30	19.33	5.56	20.30	5.89	21.52
1,000,000	17.10	17.92	4.85	17.67	5.13	18.70	5.21	19.00	5.51	20.11	5.79	21.15	6.13	22.41
2,500,000	19.41	20.15	5.48	20.00	5.78	21.11	5.91	21.59	6.23	22.78	6.57	24.04	6.93	25.37
5,000,000	21.26	21.92	6.00	21.93	6.31	23.07	6.47	23.67	6.81	24.93	7.19	26.33	7.57	27.74
7,500,000	22.39	22.98	6.31	23.07	6.65	24.33	6.81	24.93	7.17	26.26	7.57	27.74	7.96	29.19
10,000,000	23.21	23.74	6.55	23.96	6.89	25.22	7.07	25.89	7.43	27.22	7.85	28.78	8.25	30.26
15,000,000	24.38	24.84	6.89	25.22	7.24	26.52	7.43	27.22	7.82	28.67	8.25	30.26	8.67	31.81
20,000,000	25.24	25.63	7.14	26.15	7.50	27.48	7.70	28.22	8.10	29.70	8.55	31.37	8.98	32.96
25,000,000	25.92	26.25	7.34	26.89	7.71	28.26	7.92	29.04	8.21	30.11	8.78	32.22	9.22	33.85
30,000,000	26.47	26.76	7.50	27.48	7.88	28.89	8.10	29.70	8.51	31.22	8.98	32.96	9.43	34.63
35,000,000	26.95	27.20	7.64	28.00	8.03	29.44	8.25	30.26	8.67	31.81	9.15	33.59	9.61	35.30
40,000,000	27.37	27.58	7.77	28.48	8.16	29.93	8.39	30.78	8.81	32.33	9.30	34.15	9.76	35.85
45,000,000	27.74	27.92	7.88	28.89	8.28	30.37	8.51	31.22	8.93	32.78	9.43	34.63	9.90	36.37
50,000,000	28.07	28.22	7.98	29.26	8.38	30.74	8.61	31.59	9.05	33.22	9.55	35.07	10.02	36.81
75,000,000	29.38	29.40	8.38	30.74	8.80	32.30	9.05	33.22	9.50	34.89	10.02	36.81	10.52	38.67
100,000,000	30.32	30.25	8.68	31.85	9.11	33.44	9.36	34.37	9.82	36.07	10.37	38.11	10.88	40.00

CBR = 5 Mr = 2911 %REL = 90	AC=50%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	11.31	12.06	3.33	12.04	3.53	12.78	3.48	12.59	3.72	13.48	3.76	13.63	4.05	14.70
250,000	13.15	13.84	3.81	13.81	4.04	14.67	4.03	14.63	4.30	15.63	4.43	16.11	4.74	17.26
500,000	14.64	15.27	4.21	15.30	4.45	16.19	4.49	16.33	4.76	17.33	4.97	18.11	5.29	19.30
750,000	15.55	16.15	4.45	16.19	4.71	17.15	4.76	17.33	5.05	18.41	5.29	19.30	5.61	20.48
1,000,000	16.22	16.79	4.63	16.85	4.90	17.85	4.97	18.11	5.26	19.19	5.52	20.15	5.85	21.37
2,500,000	18.45	18.90	5.24	19.11	5.53	20.19	5.64	20.59	5.96	21.78	6.27	22.93	6.62	24.22
5,000,000	20.23	20.60	5.74	20.96	6.05	22.11	6.19	22.63	6.52	23.85	6.88	25.19	7.25	26.56
7,500,000	21.32	21.62	6.05	22.11	6.37	23.30	6.52	23.85	6.87	25.15	7.25	26.56	7.63	27.96
10,000,000	22.11	22.36	6.27	22.93	6.60	24.15	6.77	24.78	7.12	26.07	7.52	27.56	7.91	29.00
15,000,000	23.25	23.43	6.60	24.15	6.94	25.41	7.12	26.07	7.49	27.44	7.91	29.00	8.32	30.52
20,000,000	24.08	24.21	6.84	25.04	7.19	26.33	7.38	27.04	7.76	28.44	8.20	30.07	8.61	31.59
25,000,000	24.73	24.82	7.03	25.74	7.39	27.07	7.59	27.81	7.98	29.26	8.42	30.89	8.85	32.48
30,000,000	25.27	25.32	7.19	26.33	7.56	27.70	7.76	28.44	8.16	29.93	8.61	31.59	9.05	33.22
35,000,000	25.73	25.75	7.33	26.85	7.71	28.26	7.91	29.00	8.31	30.48	8.78	32.22	9.22	33.85
40,000,000	26.14	26.13	7.45	27.30	7.83	28.70	8.04	29.48	8.45	31.00	8.92	32.74	9.37	34.41
45,000,000	26.49	26.46	7.56	27.70	7.94	29.11	8.16	29.93	8.57	31.44	9.05	33.22	9.50	34.89
50,000,000	26.82	26.76	7.66	28.07	8.05	29.52	8.27	30.33	8.68	31.85	9.17	33.67	9.62	35.33
75,000,000	28.08	27.93	8.05	29.52	8.45	31.00	8.68	31.85	9.12	33.48	9.62	35.33	10.10	37.11
100,000,000	28.99	28.78	8.33	30.56	8.75	32.11	8.99	33.00	9.43	34.63	9.96	36.59	10.45	38.41

FIGURE E8. THICKNESS DESIGNS FOR 50% AC, 50% CS, CBR 6 AND CBR 7.

CBR = 6 Mr = 3283 %REL = 90	AC=50%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	10.63	11.46	3.19	11.52	3.39	12.26	3.32	12.00	3.55	12.85	3.57	12.93	3.85	13.96
250,000	12.45	13.13	3.66	13.26	3.88	14.07	3.86	14.00	4.11	14.93	4.22	15.33	4.53	16.48
500,000	13.92	14.48	4.04	14.67	4.28	15.56	4.30	15.63	4.57	16.63	4.75	17.30	5.07	18.48
750,000	14.82	15.32	4.28	15.56	4.53	16.48	4.57	16.63	4.85	17.67	5.07	18.48	5.39	19.67
1,000,000	15.48	15.92	4.46	16.22	4.71	17.15	4.77	17.37	5.06	18.44	5.29	19.30	5.62	20.52
2,500,000	17.67	17.96	5.05	18.41	5.33	19.44	5.43	19.81	5.74	20.96	6.04	22.07	6.38	23.33
5,000,000	19.42	19.60	5.54	20.22	5.83	21.30	5.96	21.78	6.29	23.00	6.63	24.26	6.99	25.59
7,500,000	20.49	20.60	5.83	21.30	6.15	22.48	6.29	23.00	6.63	24.26	6.99	25.59	7.36	26.96
10,000,000	21.26	21.33	6.05	22.11	6.37	23.30	6.53	23.89	6.88	25.19	7.25	26.56	7.64	28.00
15,000,000	22.37	22.38	6.37	23.30	6.71	24.56	6.88	25.19	7.24	26.52	7.64	28.00	8.03	29.44
20,000,000	23.18	23.14	6.61	24.19	6.95	25.44	7.13	26.11	7.50	27.48	7.92	29.04	8.33	30.56
25,000,000	23.82	23.74	6.80	24.89	7.15	26.19	7.33	26.85	7.71	28.26	8.14	29.85	8.56	31.41
30,000,000	24.34	24.24	6.95	25.44	7.31	26.78	7.50	27.48	7.89	28.93	8.33	30.56	8.75	32.11
35,000,000	24.79	24.66	7.08	25.93	7.45	27.30	7.65	28.04	8.04	29.48	8.48	31.11	8.92	32.74
40,000,000	25.19	25.03	7.20	26.37	7.57	27.74	7.77	28.48	8.17	29.96	8.62	31.63	9.06	33.26
45,000,000	25.54	25.36	7.31	26.78	7.68	28.15	7.89	28.93	8.29	30.41	8.75	32.11	9.19	33.74
50,000,000	25.85	25.66	7.40	27.11	7.78	28.52	7.99	29.30	8.39	30.78	8.86	32.52	9.31	34.19
75,000,000	27.08	26.83	7.78	28.52	8.17	29.96	8.39	30.78	8.81	32.33	9.31	34.19	9.77	35.89
100,000,000	27.97	27.67	8.05	29.52	8.46	31.04	8.69	31.89	9.13	33.52	9.63	35.37	10.11	37.15

CBR = 7 Mr = 3635 %REL = 90	AC=50%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	10.09	10.93	3.08	11.11	3.27	11.81	3.20	11.56	3.42	12.37	3.41	12.33	3.68	13.33
250,000	11.88	12.52	3.53	12.78	3.75	13.59	3.71	13.44	3.96	14.37	4.05	14.70	4.35	15.81
500,000	13.33	13.82	3.91	14.19	4.14	15.04	4.15	15.07	4.41	16.04	4.57	16.63	4.88	17.78
750,000	14.21	14.63	4.14	15.04	4.38	15.93	4.41	16.04	4.69	17.07	4.88	17.78	5.20	18.96
1,000,000	14.85	15.22	4.31	15.67	4.56	16.59	4.61	16.78	4.89	17.81	5.11	18.63	5.43	19.81
2,500,000	17.00	17.20	4.89	17.81	5.17	18.85	5.26	19.19	5.56	20.30	5.84	21.33	6.18	22.59
5,000,000	18.72	18.80	5.37	19.59	5.66	20.67	5.78	21.11	6.10	22.30	6.43	23.52	6.78	24.81
7,500,000	19.76	19.78	5.66	20.67	5.96	21.78	6.10	22.30	6.43	23.52	6.78	24.81	7.15	26.19
10,000,000	20.51	20.50	5.87	21.44	6.19	22.63	6.33	23.15	6.67	24.41	7.04	25.78	7.41	27.15
15,000,000	21.60	21.53	6.19	22.63	6.51	23.81	6.67	24.41	7.03	25.74	7.41	27.15	7.80	28.59
20,000,000	22.39	22.28	6.41	23.44	6.75	24.70	6.92	25.33	7.28	26.67	7.69	28.19	8.09	29.67
25,000,000	23.02	22.87	6.60	24.15	6.94	25.41	7.12	26.07	7.49	27.44	7.90	28.96	8.31	30.48
30,000,000	23.53	23.36	6.75	24.70	7.10	26.00	7.28	26.67	7.66	28.07	8.09	29.67	8.50	31.19
35,000,000	23.97	23.78	6.88	25.19	7.23	26.48	7.43	27.22	8.05	29.52	8.24	30.22	8.66	31.78
40,000,000	24.35	24.15	6.99	25.59	7.35	26.93	7.55	27.67	7.94	29.11	8.38	30.74	8.80	32.30
45,000,000	24.70	24.47	7.10	26.00	7.46	27.33	7.66	28.07	8.05	29.52	8.50	31.19	8.93	32.78
50,000,000	25.00	24.77	7.19	26.33	7.56	27.70	7.76	28.44	8.16	29.93	8.61	31.59	9.05	33.22
75,000,000	26.20	25.92	7.56	27.70	7.94	29.11	8.16	29.93	8.57	31.44	9.05	33.22	9.50	34.89
100,000,000	27.07	26.75	7.83	28.70	8.22	30.15	8.45	31.00	8.87	32.56	9.36	34.37	9.83	36.11

FIGURE E9. THICKNESS DESIGNS FOR 50% AC, 50% CS, CBR 8 AND CBR 9.

CBR = 8 Mr = 3969 %REL = 90	AC=50%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	9.63	10.52	2.99	10.78	3.17	2.97	3.09	11.15	3.31	11.96	3.20	11.56	3.54	12.81
250,000	11.39	12.10	3.43	12.41	3.64	3.84	3.59	13.00	3.84	13.93	3.90	14.15	4.20	15.26
500,000	12.81	13.38	3.79	13.74	4.02	4.55	4.02	14.59	4.28	15.56	4.41	16.04	4.72	17.19
750,000	13.68	14.17	4.02	14.59	4.26	4.99	4.28	15.56	4.55	16.56	4.72	17.19	5.04	18.37
1,000,000	14.31	14.75	4.19	15.22	4.44	5.32	4.47	16.26	4.75	17.30	4.95	18.04	5.27	19.22
2,500,000	16.42	16.69	4.76	17.33	5.03	6.42	5.11	18.63	5.41	19.74	5.68	20.74	6.01	21.96
5,000,000	18.10	18.25	5.22	19.04	5.51	7.31	5.62	20.52	5.94	21.70	6.25	22.85	6.60	24.15
7,500,000	19.13	19.20	5.51	20.11	5.81	7.86	5.94	21.70	6.26	22.89	6.60	24.15	6.96	25.48
10,000,000	19.87	19.89	5.72	20.89	6.03	8.27	6.17	22.56	6.50	23.78	6.85	25.07	7.22	26.44
15,000,000	20.94	20.88	6.03	22.04	6.35	8.86	6.50	23.78	6.85	25.07	7.22	26.44	7.60	27.85
20,000,000	21.71	21.61	6.25	22.85	6.58	9.29	6.74	24.67	7.10	26.00	7.49	27.44	7.88	28.89
25,000,000	22.32	22.18	6.43	23.52	6.77	9.64	6.94	25.41	7.30	26.74	7.71	28.26	8.11	29.74
30,000,000	22.83	22.65	6.58	24.07	6.92	9.92	7.10	26.00	7.47	27.37	7.88	28.89	8.29	30.41
35,000,000	23.26	23.06	6.71	24.56	7.05	10.16	7.24	26.52	7.61	27.89	8.04	29.48	8.45	31.00
40,000,000	23.64	23.41	6.82	24.96	7.17	10.38	7.36	26.96	7.74	28.37	8.17	29.96	8.59	31.52
45,000,000	23.97	23.73	6.92	25.33	7.28	10.58	7.47	27.37	7.85	28.78	8.29	30.41	8.71	31.96
50,000,000	24.27	24.01	7.01	25.67	7.37	10.75	7.57	27.74	7.95	29.15	8.40	30.81	8.83	32.41
75,000,000	25.45	25.12	7.37	27.00	7.75	11.45	7.95	29.15	8.36	30.67	8.83	32.41	9.27	34.04
100,000,000	26.30	25.92	7.64	28.00	8.02	11.95	8.24	30.22	8.66	31.78	9.14	33.56	9.59	35.22

CBR = 9 Mr = 4290 %REL = 90	AC=50%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	9.20	10.15	2.90	10.44	3.09	11.15	3.00	10.81	3.21	11.59	3.17	11.44	3.42	12.37
250,000	10.94	11.68	3.34	12.07	3.54	12.81	3.49	12.63	3.73	13.52	3.77	13.67	4.06	14.74
500,000	12.34	12.93	3.70	13.41	3.92	14.22	3.90	14.15	4.16	15.11	4.28	15.56	4.58	16.67
750,000	13.20	13.70	3.92	14.22	4.15	15.07	4.16	15.11	4.43	16.11	4.58	16.67	4.90	17.85
1,000,000	13.82	14.27	4.08	14.81	4.33	15.74	4.35	15.81	4.62	16.81	4.81	17.52	5.12	18.67
2,500,000	15.89	16.17	4.64	16.89	4.91	17.89	4.98	18.15	5.27	19.22	5.53	20.19	5.86	21.41
5,000,000	17.54	17.71	5.10	18.59	5.38	19.63	5.49	20.04	5.80	21.19	6.10	22.30	6.44	23.56
7,500,000	18.54	18.65	5.38	19.63	5.67	20.70	5.80	21.19	6.12	22.37	6.44	23.56	6.80	24.89
10,000,000	19.27	19.34	5.59	20.41	5.89	21.52	6.02	22.00	6.35	23.22	6.69	24.48	7.06	25.85
15,000,000	20.31	20.33	5.89	21.52	6.20	22.67	6.35	23.22	6.69	24.48	7.06	25.85	7.43	27.22
20,000,000	21.07	21.05	6.11	22.33	6.43	23.52	6.59	24.11	6.94	25.41	7.32	26.81	7.71	28.26
25,000,000	21.66	21.62	6.28	22.96	6.61	24.19	6.78	24.81	7.14	26.15	7.53	27.59	7.93	29.07
30,000,000	22.16	22.09	6.43	23.52	6.77	24.78	6.94	25.41	7.30	26.74	7.71	28.26	8.11	29.74
35,000,000	22.58	22.49	6.56	24.00	6.90	25.26	7.08	25.93	7.45	27.30	7.86	28.81	8.26	30.30
40,000,000	22.94	22.84	6.67	24.41	7.01	25.67	7.20	26.37	7.57	27.74	7.99	29.30	8.40	30.81
45,000,000	23.27	23.16	6.77	24.78	7.12	26.07	7.30	26.74	7.68	28.15	8.11	29.74	8.52	31.26
50,000,000	23.56	23.44	6.86	25.11	7.21	26.41	7.40	27.11	7.78	28.52	8.21	30.11	8.63	31.67
75,000,000	24.71	24.55	7.21	26.41	7.58	27.78	7.78	28.52	8.18	30.00	8.63	31.67	9.07	33.30
100,000,000	25.54	25.35	7.47	27.37	7.85	28.78	8.06	29.56	8.47	31.07	8.94	32.81	9.39	34.48

FIGURE E10. THICKNESS DESIGNS FOR 50% AC, 50% CS, CBR 10 AND CBR 11.

CBR = 10 Mr = 4598 %REL = 90	AC=50%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	8.82	9.84	2.83	10.19	3.02	10.89	2.92	10.52	3.12	11.26	3.07	11.07	3.32	12.00
250,000	10.55	11.33	3.26	11.78	3.46	12.52	3.40	12.30	3.63	13.15	3.66	13.26	3.95	14.33
500,000	11.94	12.56	3.61	13.07	3.83	13.89	3.80	13.78	4.06	14.74	4.16	15.11	4.46	16.22
750,000	12.78	13.32	3.83	13.89	4.06	14.74	4.06	14.74	4.32	15.70	4.46	16.22	4.77	17.37
1,000,000	13.4[illegible]	13.88	3.99	14.48	4.23	15.37	4.24	15.41	4.51	16.41	4.68	17.04	5.00	18.22
2,500,000	15.4[illegible]	15.75	4.54	16.52	4.80	17.48	4.86	17.70	5.16	18.81	5.40	19.70	5.73	20.93
5,000,000	17.07	17.27	4.99	18.19	5.27	19.22	5.37	19.59	5.67	20.70	5.96	21.78	6.30	23.04
7,500,000	18.06	18.19	5.27	19.22	5.56	20.30	5.67	20.70	5.99	21.89	6.30	23.04	6.66	24.37
10,000,000	18.77	18.87	5.47	19.96	5.77	21.07	5.89	21.52	6.22	22.74	6.55	23.96	6.91	25.30
15,000,000	19.80	19.85	5.77	21.07	6.08	22.22	6.22	22.74	6.55	23.96	6.91	25.30	7.28	26.67
20,000,000	20.55	20.56	5.99	21.89	6.30	23.04	6.46	23.63	6.80	24.89	7.17	26.26	7.55	27.67
25,000,000	21.14	21.12	6.16	22.52	6.48	23.70	6.64	24.30	6.99	25.59	7.38	27.04	7.77	28.48
30,000,000	21.62	21.59	6.30	23.04	6.63	24.26	6.80	24.89	7.16	26.22	7.55	27.67	7.95	29.15
35,000,000	22.04	21.98	6.43	23.52	6.76	24.74	6.93	25.37	7.30	26.74	7.70	28.22	8.10	29.70
40,000,000	22.40	22.33	6.54	23.93	6.87	25.15	7.05	25.81	7.42	27.19	7.83	28.70	8.24	30.22
45,000,000	22.72	22.64	6.63	24.26	6.98	25.56	7.16	26.22	7.53	27.59	7.95	29.15	8.36	30.67
50,000,000	23.01	22.92	6.72	24.59	7.07	25.89	7.25	26.56	7.63	27.96	8.05	29.52	8.46	31.04
75,000,000	24.14	24.02	7.07	25.89	7.43	27.22	7.63	27.96	8.02	29.41	8.46	31.04	8.89	32.63
100,000,000	24.95	24.81	7.32	26.81	7.70	28.22	7.90	28.96	8.30	30.44	8.77	32.19	9.21	33.81

CBR = 11 Mr = 4897 %REL = 90	AC=50%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	8.44	9.49	2.77	9.96	2.95	10.63	2.85	10.26	3.05	11.00	2.99	10.78	3.23	11.67
250,000	10.17	10.98	3.19	11.52	3.39	12.26	3.32	12.00	3.55	12.85	3.56	12.89	3.84	13.93
500,000	11.56	12.20	3.53	12.78	3.75	13.59	3.72	13.48	3.96	14.37	4.05	14.70	4.35	15.81
750,000	12.40	12.95	3.75	13.59	3.98	14.44	3.96	14.37	4.22	15.33	4.35	15.81	4.66	16.96
1,000,000	13.01	13.51	3.91	14.19	4.14	15.04	4.15	15.07	4.41	16.04	4.57	16.63	4.88	17.78
2,500,000	15.05	15.37	4.45	16.19	4.71	17.15	4.76	17.33	5.05	18.41	5.28	19.26	5.61	20.48
5,000,000	16.66	16.87	4.89	17.81	5.17	18.85	5.26	19.19	5.56	20.30	5.84	21.33	6.18	22.59
7,500,000	17.64	17.79	5.17	18.85	5.45	19.89	5.56	20.30	5.87	21.44	6.18	22.59	6.53	23.89
10,000,000	18.35	18.47	5.37	19.59	5.66	20.67	5.78	21.11	6.10	22.30	6.43	23.52	6.78	24.81
15,000,000	19.37	19.44	5.66	20.67	5.96	21.78	6.10	22.30	6.43	23.52	6.78	24.81	7.15	26.19
20,000,000	20.11	20.14	5.87	21.44	6.19	22.63	6.33	23.15	6.67	24.41	7.04	25.78	7.42	27.19
25,000,000	20.69	20.70	6.04	22.07	6.36	23.26	6.52	23.85	6.87	25.15	7.25	26.56	7.63	27.96
30,000,000	21.17	21.17	6.19	22.63	6.51	23.81	6.67	24.41	7.03	25.74	7.42	27.19	7.80	28.59
35,000,000	21.57	21.56	6.31	23.07	6.64	24.30	6.81	24.93	7.17	26.26	7.56	27.70	7.96	29.19
40,000,000	21.93	21.91	6.42	23.48	6.75	24.70	6.92	25.33	7.29	26.70	7.69	28.19	8.09	29.67
45,000,000	22.25	22.22	6.51	23.81	6.85	25.07	7.03	25.74	7.39	27.07	7.80	28.59	8.21	30.11
50,000,000	22.53	22.49	6.60	24.15	6.94	25.41	7.12	26.07	7.49	27.44	7.91	29.00	8.31	30.48
75,000,000	23.65	23.58	6.94	25.41	7.30	26.74	7.49	27.44	7.88	28.89	8.31	30.48	8.74	32.07
100,000,000	24.45	24.37	7.19	26.33	7.56	27.70	7.76	28.44	8.16	29.93	8.61	31.59	9.05	33.22

FIGURE E11. THICKNESS DESIGNS FOR 75% AC, 25% CS, CBR 2 AND CBR 3.

CBR = 2 Mr = 1591 %REL = 90	AC=75%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	10.61	10.67	4.08	11.94	4.32	12.66	4.35	12.75	4.62	13.55	4.80	14.09	5.12	15.04
250,000	12.22	12.88	4.64	13.61	4.91	14.42	4.98	14.63	5.27	15.49	5.53	16.27	5.86	17.25
500,000	13.53	14.48	5.10	14.99	5.38	15.82	5.48	16.12	5.80	17.07	6.10	17.97	6.44	18.99
750,000	14.33	15.40	5.38	15.82	5.67	16.69	5.80	17.07	6.12	18.03	6.44	18.99	6.80	20.06
1,000,000	14.92	16.04	5.59	16.45	5.89	17.34	6.02	17.73	6.35	18.72	6.69	19.73	7.06	20.84
2,500,000	16.88	18.01	6.28	18.51	6.61	19.49	6.78	20.00	7.14	21.07	7.53	22.24	7.92	23.40
5,000,000	18.47	19.45	6.86	20.24	7.21	21.28	7.40	21.85	7.78	22.99	8.21	24.27	8.63	25.52
7,500,000	19.43	20.26	7.21	21.28	7.58	22.39	7.78	22.99	8.18	24.18	8.63	25.52	9.07	26.84
10,000,000	20.13	20.83	7.47	22.06	7.85	23.19	8.06	23.82	8.47	25.04	8.94	26.45	9.39	27.79
15,000,000	21.15	21.61	7.85	23.19	8.24	24.36	8.47	25.04	8.89	26.30	9.39	27.79	9.85	29.16
20,000,000	21.88	22.15	8.12	24.00	8.53	25.22	8.77	25.94	9.20	27.22	9.72	28.78	10.20	30.21
25,000,000	22.46	22.57	8.35	24.69	8.76	25.91	9.00	26.63	9.45	27.97	9.98	29.55	10.47	31.01
30,000,000	22.95	22.90	8.53	25.22	8.96	26.51	9.20	27.22	9.66	28.60	10.20	30.21	10.70	31.70
35,000,000	23.36	23.19	8.69	25.70	9.12	26.99	9.37	27.73	9.84	29.13	10.38	30.75	10.89	32.27
40,000,000	23.72	23.43	8.83	26.12	9.27	27.43	9.52	28.18	10.00	29.61	10.55	31.25	11.07	32.81
45,000,000	24.04	23.64	8.96	26.51	9.40	27.82	9.66	28.60	10.13	30.00	10.70	31.70	11.22	33.25
50,000,000	24.32	23.83	9.07	26.84	9.52	28.18	9.78	28.96	10.26	30.39	10.83	32.09	11.36	33.67
75,000,000	25.45	24.54	9.52	28.18	9.98	29.55	10.26	30.39	10.76	31.88	11.36	33.67	11.91	35.31
100,000,000	26.26	25.03	9.85	29.16	10.33	30.60	10.62	31.46	11.13	32.99	11.75	34.84	12.31	36.51

CBR = 3 Mr = 2092 %REL = 90	AC=75%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	9.82	9.82	3.73	10.90	3.96	11.58	3.95	11.55	4.21	12.33	4.33	12.69	4.64	13.61
250,000	11.36	11.66	4.26	12.48	4.51	13.22	4.55	13.34	4.83	14.18	5.03	14.78	5.35	15.73
500,000	12.63	13.06	4.69	13.76	4.95	14.54	5.03	14.78	5.32	15.64	5.59	16.45	5.92	17.43
750,000	13.40	13.88	4.95	14.54	5.23	15.37	5.32	15.64	5.63	16.57	5.92	17.43	6.26	18.45
1,000,000	13.97	14.47	5.15	15.13	5.43	15.97	5.54	16.30	5.85	17.22	6.16	18.15	6.50	19.16
2,500,000	15.87	16.35	5.81	17.10	6.11	18.00	6.26	18.45	6.60	19.46	6.96	20.54	7.33	21.64
5,000,000	17.40	17.79	6.34	18.69	6.67	19.67	6.84	20.18	7.20	21.25	7.60	22.45	8.00	23.64
7,500,000	18.34	18.63	6.67	19.67	7.02	20.72	7.20	21.25	7.58	22.39	8.00	23.64	8.41	24.87
10,000,000	19.02	19.23	6.92	20.42	7.27	21.46	7.47	22.06	7.85	23.19	8.29	24.51	8.71	25.76
15,000,000	20.00	20.08	7.27	21.46	7.64	22.57	7.85	23.19	8.25	24.39	8.71	25.76	9.15	27.07
20,000,000	20.71	20.69	7.53	22.24	7.92	23.40	8.13	24.03	8.54	25.25	9.02	26.69	9.47	28.03
25,000,000	21.27	21.16	7.74	22.87	8.13	24.03	8.35	24.69	8.77	25.94	9.26	27.40	9.73	28.81
30,000,000	21.73	21.54	7.92	23.40	8.31	24.57	8.54	25.25	8.97	26.54	9.47	28.03	9.94	29.43
35,000,000	22.13	21.87	8.06	23.82	8.47	25.04	8.70	25.73	9.14	27.04	9.65	28.57	10.12	29.97
40,000,000	22.48	22.15	8.20	24.24	8.61	25.46	8.84	26.15	9.28	27.46	9.80	29.01	10.28	30.45
45,000,000	22.79	22.40	8.31	24.57	8.73	25.82	8.97	26.54	9.41	27.85	9.94	29.43	10.43	30.90
50,000,000	23.07	22.62	8.42	24.90	8.84	26.15	9.08	26.87	9.53	28.21	10.06	29.79	10.56	31.28
75,000,000	24.16	23.49	8.84	26.15	9.28	27.46	9.53	28.21	10.00	29.61	10.56	31.28	11.08	32.84
100,000,000	24.94	24.10	9.15	27.07	9.60	28.42	9.87	29.22	10.35	30.66	10.92	32.36	11.45	33.94

FIGURE E12. THICKNESS DESIGNS FOR 75% AC, 25% CS, CBR 4 AND CBR 5.

CBR = 4 Mr = 2513 %REL = 90	AC=75%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	9.25	8.82	3.50	10.21	*3.72*	*10.87*	3.68	10.75	*3.93*	*11.49*	4.00	11.70	*4.31*	*12.63*
250,000	10.67	10.68	4.00	11.70	*4.24*	*12.42*	4.25	12.45	*4.52*	*13.25*	4.69	13.76	*5.01*	*14.72*
500,000	11.86	12.10	4.41	12.93	*4.67*	*13.70*	4.72	13.85	*5.01*	*14.72*	5.23	15.37	*5.56*	*16.36*
750,000	12.60	12.93	4.67	13.70	*4.93*	*14.48*	5.01	14.72	*5.30*	*15.58*	5.56	16.36	*5.89*	*17.34*
1,000,000	13.15	13.52	4.85	14.24	*5.13*	*15.07*	5.21	15.31	*5.51*	*16.21*	5.79	17.04	*6.13*	*18.06*
2,500,000	15.00	15.41	5.48	16.12	*5.78*	*17.01*	5.91	17.40	*6.23*	*18.36*	6.57	19.37	*6.93*	*20.45*
5,000,000	16.52	16.85	6.00	17.67	*6.31*	*18.60*	6.47	19.07	*6.81*	*20.09*	7.19	21.22	*7.57*	*22.36*
7,500,000	17.46	17.69	6.31	18.60	*6.65*	*19.61*	6.81	20.09	*7.17*	*21.16*	7.57	22.36	*7.96*	*23.52*
10,000,000	18.14	18.29	6.55	19.31	*6.89*	*20.33*	7.07	20.87	*7.43*	*21.94*	7.85	23.19	*8.25*	*24.39*
15,000,000	19.14	19.14	6.89	20.33	*7.24*	*21.37*	7.43	21.94	*7.82*	*23.10*	8.25	24.39	*8.67*	*25.64*
20,000,000	19.86	19.74	7.14	21.07	*7.50*	*22.15*	7.70	22.75	*8.10*	*23.94*	8.55	25.28	*8.98*	*26.57*
25,000,000	20.44	20.21	7.34	21.67	*7.71*	*22.78*	7.92	23.40	*8.21*	*24.27*	8.78	25.97	*9.22*	*27.28*
30,000,000	20.91	20.59	7.50	22.15	*7.88*	*23.28*	8.10	23.94	*8.51*	*25.16*	8.98	26.57	*9.43*	*27.91*
35,000,000	21.32	20.91	7.64	22.57	*8.03*	*23.73*	8.25	24.39	*8.67*	*25.64*	9.15	27.07	*9.61*	*28.45*
40,000,000	21.68	21.19	7.77	22.96	*8.16*	*24.12*	8.39	24.81	*8.81*	*26.06*	9.30	27.52	*9.76*	*28.90*
45,000,000	22.00	21.44	7.88	23.28	*8.28*	*24.48*	8.51	25.16	*8.93*	*26.42*	9.43	27.91	*9.90*	*29.31*
50,000,000	22.29	21.66	7.98	23.58	*8.38*	*24.78*	8.61	25.46	*9.05*	*26.78*	9.55	28.27	*10.02*	*29.67*
75,000,000	23.42	22.52	8.38	24.78	*8.80*	*26.03*	9.05	26.78	*9.50*	*28.12*	10.02	29.67	*10.52*	*31.16*
100,000,000	24.24	23.13	8.68	25.67	*9.11*	*26.96*	9.36	27.70	*9.82*	*29.07*	10.37	30.72	*10.88*	*32.24*

CBR = 5 Mr = 2911 %REL = 90	AC=75%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	8.77	8.25	3.33	9.70	*3.53*	*10.30*	3.48	10.15	*3.72*	*10.87*	3.76	10.99	*4.05*	*11.85*
250,000	10.13	10.05	3.81	11.13	*5.45*	*16.03*	4.03	11.79	*4.30*	*12.60*	4.43	12.99	*4.74*	*13.91*
500,000	11.28	11.43	4.21	12.33	*4.45*	*13.04*	4.49	13.16	*4.76*	*13.97*	4.97	14.60	*5.29*	*15.55*
750,000	12.00	12.24	4.45	13.04	*4.71*	*13.82*	4.76	13.97	*5.05*	*14.84*	5.29	15.55	*5.61*	*16.51*
1,000,000	12.53	12.82	4.63	13.58	*4.90*	*14.39*	4.97	14.60	*5.26*	*15.46*	5.52	16.24	*5.85*	*17.22*
2,500,000	14.35	14.69	5.24	15.40	*5.53*	*16.27*	5.64	16.60	*5.96*	*17.55*	6.27	18.48	*6.62*	*19.52*
5,000,000	15.85	16.12	5.74	16.90	*6.05*	*17.82*	6.19	18.24	*6.52*	*19.22*	6.88	20.30	*7.25*	*21.40*
7,500,000	16.77	16.97	6.05	17.82	*6.37*	*18.78*	6.52	19.22	*6.87*	*20.27*	7.25	21.40	*7.63*	*22.54*
10,000,000	17.45	17.57	6.27	18.48	*6.60*	*19.46*	6.77	19.97	*7.12*	*21.01*	7.52	22.21	*7.91*	*23.37*
15,000,000	18.43	18.42	6.60	19.46	*6.94*	*20.48*	7.12	21.01	*7.49*	*22.12*	7.91	23.37	*8.32*	*24.60*
20,000,000	19.15	19.03	6.84	20.18	*7.19*	*21.22*	7.38	21.79	*7.76*	*22.93*	8.20	24.24	*8.61*	*25.46*
25,000,000	19.72	19.51	7.03	20.75	*7.39*	*21.82*	7.59	22.42	*7.98*	*23.58*	8.42	24.90	*8.85*	*26.18*
30,000,000	20.19	19.90	7.19	21.22	*7.56*	*22.33*	7.76	22.93	*8.16*	*24.12*	8.61	25.46	*9.05*	*26.78*
35,000,000	20.60	20.22	7.33	21.64	*7.71*	*22.78*	7.91	23.37	*8.31*	*24.57*	8.78	25.97	*9.22*	*27.28*
40,000,000	20.96	20.51	7.45	22.00	*7.83*	*23.13*	8.04	23.76	*8.45*	*24.99*	8.92	26.39	*9.37*	*27.73*
45,000,000	21.28	20.76	7.56	22.33	*7.94*	*23.46*	8.16	24.12	*8.57*	*25.34*	9.05	26.78	*9.50*	*28.12*
50,000,000	21.56	20.99	7.66	22.63	*8.05*	*23.79*	8.27	24.45	*8.68*	*25.67*	9.17	27.13	*9.62*	*28.48*
75,000,000	22.69	21.86	8.05	23.79	*8.45*	*24.99*	8.68	25.67	*9.12*	*26.99*	9.62	28.48	*10.10*	*29.91*
100,000,000	23.51	22.49	8.33	24.63	*8.75*	*25.88*	8.99	26.60	*9.43*	*27.91*	9.96	29.49	*10.45*	*30.96*

FIGURE E13. THICKNESS DESIGNS FOR 75% AC, 25% CS, CBR 6 AND CBR 7.

CBR = 6 Mr = 3283 %REL = 90	AC=75%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	8.32	7.52	3.19	9.28	3.39	9.88	3.32	9.67	3.55	10.36	3.57	10.42	3.85	11.25
250,000	9.68	9.39	3.66	10.69	3.88	11.34	3.86	11.28	4.11	12.03	4.22	12.36	4.53	13.28
500,000	10.82	10.81	4.04	11.82	4.28	12.54	4.30	12.60	4.57	13.40	4.75	13.94	5.07	14.90
750,000	11.53	11.65	4.28	12.54	4.53	13.28	4.57	13.40	4.85	14.24	5.07	14.90	5.39	15.85
1,000,000	12.06	12.24	4.46	13.07	4.71	13.82	4.77	14.00	5.06	14.87	5.29	15.55	5.62	16.54
2,500,000	13.86	14.13	5.05	14.84	5.33	15.67	5.43	15.97	5.74	16.90	6.04	17.79	6.38	18.81
5,000,000	15.34	15.57	5.54	16.30	5.83	17.16	5.96	17.55	6.29	18.54	6.63	19.55	6.99	20.63
7,500,000	16.25	16.41	5.83	17.16	6.15	18.12	6.29	18.54	6.63	19.55	6.99	20.63	7.36	21.73
10,000,000	16.92	17.00	6.05	17.82	6.37	18.78	6.53	19.25	6.88	20.30	7.25	21.40	7.64	22.57
15,000,000	17.88	17.85	6.37	18.78	6.71	19.79	6.88	20.30	7.24	21.37	7.64	22.57	8.03	23.73
20,000,000	18.59	18.45	6.61	19.49	6.95	20.51	7.13	21.04	7.50	22.15	7.92	23.40	8.33	24.63
25,000,000	19.16	18.91	6.80	20.06	7.15	21.10	7.33	21.64	7.71	22.78	8.14	24.06	8.56	25.31
30,000,000	19.62	19.30	6.95	20.51	7.31	21.58	7.50	22.15	7.89	23.31	8.33	24.63	8.75	25.88
35,000,000	20.02	19.62	7.08	20.90	7.45	22.00	7.65	22.60	8.04	23.76	8.48	25.07	8.92	26.39
40,000,000	20.37	19.90	7.20	21.25	7.57	22.36	7.77	22.96	8.17	24.15	8.62	25.49	9.06	26.81
45,000,000	20.68	20.14	7.31	21.58	7.68	22.69	7.89	23.31	8.29	24.51	8.75	25.88	9.19	27.19
50,000,000	20.97	20.36	7.40	21.85	7.78	22.99	7.99	23.61	8.39	24.81	8.86	26.21	9.31	27.55
75,000,000	22.07	21.21	7.78	22.99	8.17	24.15	8.39	24.81	8.81	26.06	9.31	27.55	9.77	28.93
100,000,000	22.88	21.82	8.05	23.79	8.46	25.01	8.69	25.70	9.13	27.01	9.63	28.51	10.11	29.94

CBR = 7 Mr = 3635 %REL = 90	AC=75%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	7.95	7.02	3.08	8.96	3.27	9.52	3.20	9.31	3.42	9.97	3.41	9.94	3.68	10.75
250,000	9.29	8.92	3.53	10.30	6.94	20.48	3.71	10.84	3.96	11.58	4.05	11.85	4.35	10.96
500,000	10.42	10.36	3.91	11.43	4.14	12.12	4.15	12.15	4.41	12.93	4.57	13.40	4.88	14.33
750,000	11.13	11.21	4.14	12.12	4.38	12.84	4.41	12.93	4.69	13.76	4.88	14.33	5.20	15.28
1,000,000	11.65	11.80	4.31	12.63	4.56	13.37	4.61	13.52	4.89	14.36	5.11	15.01	5.43	15.97
2,500,000	13.43	13.71	4.89	14.36	5.17	15.19	5.26	15.46	5.56	16.36	5.84	17.19	6.18	18.21
5,000,000	14.88	15.16	5.37	15.79	5.66	16.66	5.78	17.01	6.10	17.97	6.43	18.96	6.78	20.00
7,500,000	15.78	16.00	5.66	16.66	5.96	17.55	6.10	17.97	6.43	18.96	6.78	20.00	7.15	21.10
10,000,000	16.44	16.60	5.87	17.28	6.19	18.24	6.33	18.66	6.67	19.67	7.04	20.78	7.41	21.88
15,000,000	17.39	17.45	6.19	18.24	6.51	19.19	6.67	19.67	7.03	20.75	7.41	21.88	7.80	23.04
20,000,000	18.09	18.05	6.41	18.90	6.75	19.91	6.92	20.42	7.28	21.49	7.69	22.72	8.09	23.91
25,000,000	18.64	18.52	6.60	19.46	6.94	20.48	7.12	21.01	7.49	22.12	7.90	23.34	8.31	24.57
30,000,000	19.10	18.90	6.75	19.91	7.10	20.96	7.28	21.49	7.66	22.63	8.09	23.91	8.50	25.13
35,000,000	19.50	19.22	6.88	20.30	7.23	21.34	7.43	21.94	8.05	23.79	8.24	24.36	8.66	25.61
40,000,000	19.84	19.50	6.99	20.63	7.35	21.70	7.55	22.30	7.94	23.46	8.38	24.78	8.80	26.03
45,000,000	20.15	19.75	7.10	20.96	7.46	22.03	7.66	22.63	8.05	23.79	8.50	25.13	8.93	26.42
50,000,000	20.43	19.97	7.19	21.22	7.56	22.33	7.76	22.93	8.16	24.12	8.61	25.46	9.05	26.78
75,000,000	21.52	20.81	7.56	22.33	7.94	23.46	8.16	24.12	8.57	25.34	9.05	26.78	9.50	28.12
100,000,000	22.31	21.42	7.83	23.13	8.22	24.30	8.45	24.99	8.87	26.24	9.36	27.70	9.83	29.10

FIGURE E14. THICKNESS DESIGNS FOR 75% AC, 25% CS, CBR 8 AND CBR 9.

CBR = 8 Mr = 3969 %REL = 90	AC=75%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	7.60	6.67	2.99	8.69	3.17	9.22	3.09	8.99	3.31	9.64	3.20	9.31	3.54	10.33
250,000	8.89	8.54	3.43	10.00	3.64	10.63	3.59	10.48	3.84	11.22	3.90	11.40	4.20	12.30
500,000	9.99	9.96	3.79	11.07	4.02	11.76	4.02	11.76	4.28	12.54	4.41	12.93	4.72	13.85
750,000	10.68	10.80	4.02	11.76	4.26	12.48	4.28	12.54	4.55	13.34	4.72	13.85	5.04	14.81
1,000,000	11.19	11.39	4.19	12.27	4.44	13.01	4.47	13.10	4.75	13.94	4.95	14.54	5.27	15.49
2,500,000	12.94	13.29	4.76	13.97	5.03	14.78	5.11	15.01	5.41	15.91	5.68	16.72	6.01	17.70
5,000,000	14.38	14.73	5.22	15.34	5.51	16.21	5.62	16.54	5.94	17.49	6.25	18.42	6.60	19.46
7,500,000	15.27	15.58	5.51	16.21	5.81	17.10	5.94	17.49	6.26	18.45	6.60	19.46	6.96	20.54
10,000,000	15.93	16.18	5.72	16.84	6.03	17.76	6.17	18.18	6.50	19.16	6.85	20.21	7.22	21.31
15,000,000	16.88	17.04	6.03	17.76	6.35	18.72	6.50	19.16	6.85	20.21	7.22	21.31	7.60	22.45
20,000,000	17.58	17.64	6.25	18.42	6.58	19.40	6.74	19.88	7.10	20.96	7.49	22.12	7.88	23.28
25,000,000	18.13	18.11	6.43	18.96	6.77	19.97	6.94	20.48	7.30	21.55	7.71	22.78	8.11	23.97
30,000,000	18.59	18.50	6.58	19.40	6.92	20.42	7.10	20.96	7.47	22.06	7.88	23.28	8.29	24.51
35,000,000	18.99	18.82	6.71	19.79	7.05	20.81	7.24	21.37	7.61	22.48	8.04	23.76	8.45	24.99
40,000,000	19.33	19.10	6.82	20.12	7.17	21.16	7.36	21.73	7.74	22.87	8.17	24.15	8.59	25.40
45,000,000	19.64	19.35	6.92	20.42	7.28	21.49	7.47	22.06	7.85	23.19	8.29	24.51	8.71	25.76
50,000,000	19.92	19.58	7.01	20.69	7.37	21.76	7.57	22.36	7.95	23.49	8.40	24.84	8.83	26.12
75,000,000	21.02	20.43	7.37	21.76	7.75	22.90	7.95	23.49	8.36	24.72	8.83	26.12	9.27	27.43
100,000,000	21.81	21.05	7.64	22.57	8.02	23.70	8.24	24.36	8.66	25.61	9.14	27.04	9.59	28.39

CBR = 9 Mr = 4290 %REL = 90	AC=75%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	7.48	6.27	2.90	8.42	3.09	8.99	3.00	9.34	3.21	9.34	3.17	9.22	3.42	9.97
250,000	8.65	8.18	3.34	9.73	3.54	10.33	3.49	10.90	3.73	10.90	3.77	11.01	4.06	11.88
500,000	9.68	9.63	3.70	10.81	3.92	11.46	3.90	12.18	4.16	12.18	4.28	12.54	4.58	13.43
750,000	10.33	10.47	3.92	11.46	4.15	12.15	4.16	12.99	4.43	12.99	4.58	13.43	4.90	14.39
1,000,000	10.82	11.07	4.08	11.94	4.33	12.69	4.35	13.55	4.62	13.55	4.81	14.12	5.12	15.04
2,500,000	12.52	12.99	4.64	13.61	4.91	14.42	4.98	15.49	5.27	15.49	5.53	16.27	5.86	17.25
5,000,000	13.94	14.44	5.10	14.99	5.38	15.82	5.49	17.07	5.80	17.07	6.10	17.97	6.44	18.99
7,500,000	14.82	15.29	5.38	15.82	5.67	16.69	5.80	18.03	6.12	18.03	6.44	18.99	6.80	20.06
10,000,000	15.48	15.89	5.59	16.45	5.89	17.34	6.02	18.72	6.35	18.72	6.69	19.73	7.06	20.84
15,000,000	16.43	16.74	5.89	17.34	6.20	18.27	6.35	19.73	6.69	19.73	7.06	20.84	7.43	21.94
20,000,000	17.14	17.34	6.11	18.00	6.43	18.96	6.59	20.48	6.94	20.48	7.32	21.61	7.71	22.78
25,000,000	17.70	17.81	6.28	18.51	6.61	19.49	6.78	21.07	7.14	21.07	7.53	22.24	7.93	23.43
30,000,000	18.16	18.20	6.43	18.96	6.77	19.97	6.94	21.55	7.30	21.55	7.71	22.78	8.11	23.97
35,000,000	18.56	18.52	6.56	19.34	6.90	20.36	7.08	22.00	7.45	22.00	7.86	23.22	8.26	24.42
40,000,000	18.92	18.80	6.67	19.67	7.01	20.69	7.20	22.36	7.57	22.36	7.99	23.61	8.40	24.84
45,000,000	19.23	19.05	6.77	19.97	7.12	21.01	7.30	22.69	7.68	22.69	8.11	23.97	8.52	25.19
50,000,000	19.51	19.27	6.86	20.24	7.21	21.28	7.40	22.99	7.78	22.99	8.21	24.27	8.63	25.52
75,000,000	20.63	20.12	7.21	21.28	7.58	22.39	7.78	24.18	8.18	24.18	8.63	25.52	9.07	26.84
100,000,000	21.45	20.72	7.47	22.06	7.85	23.19	8.06	25.04	8.47	25.04	8.94	26.45	9.39	27.79

FIGURE E15. THICKNESS DESIGNS FOR 75% AC, 25% CS, CBR 10 AND CBR 11.

CBR = 10 Mr = 4598 %REL = 90	AC=75%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	7.18	6.06	2.83	8.21	*3.02*	*8.78*	2.92	8.48	*3.12*	*9.07*	3.07	8.93	*3.32*	*9.67*
250,000	8.36	7.92	3.26	9.49	*3.46*	*10.09*	3.40	9.91	*3.63*	*10.60*	3.66	10.69	*3.95*	*11.55*
500,000	9.39	9.34	3.61	10.54	*3.83*	*11.19*	3.80	11.10	*4.06*	*11.88*	4.16	12.18	*4.46*	*13.07*
750,000	10.04	10.18	3.83	11.19	*4.06*	*11.88*	4.06	11.88	*4.32*	*12.66*	4.46	13.07	*4.77*	*14.00*
1,000,000	10.53	10.77	3.99	11.67	*4.23*	*12.39*	4.24	12.42	*4.51*	*13.22*	4.68	13.73	*5.00*	*14.69*
2,500,000	12.21	12.67	4.54	13.31	*4.80*	*14.09*	4.86	14.27	*5.16*	*15.16*	5.40	15.88	*5.73*	*16.87*
5,000,000	13.62	14.12	4.99	14.66	*5.27*	*15.49*	5.37	15.79	*5.67*	*16.69*	5.96	17.55	*6.30*	*18.57*
7,500,000	14.49	14.97	5.27	15.49	*5.56*	*16.36*	5.67	16.69	*5.99*	*17.64*	6.30	18.57	*6.66*	*19.64*
10,000,000	15.14	15.58	5.47	16.09	*5.77*	*16.99*	5.89	17.34	*6.22*	*18.33*	6.55	19.31	*6.91*	*20.39*
15,000,000	16.08	16.43	5.77	16.99	*6.08*	*17.91*	6.22	18.33	*6.55*	*19.31*	6.91	20.39	*7.28*	*21.49*
20,000,000	16.77	17.04	5.99	17.64	*6.30*	*18.57*	6.46	19.04	*6.80*	*20.06*	7.17	21.16	*7.55*	*22.30*
25,000,000	17.32	17.51	6.16	18.15	*6.48*	*19.10*	6.64	19.58	*6.99*	*20.63*	7.38	21.79	*7.77*	*22.96*
30,000,000	17.78	17.90	6.30	18.57	*6.63*	*19.55*	6.80	20.06	*7.16*	*21.13*	7.55	22.30	*7.95*	*23.49*
35,000,000	18.17	18.23	6.43	18.96	*6.76*	*19.94*	6.93	20.45	*7.30*	*21.55*	7.70	22.75	*8.10*	*23.94*
40,000,000	18.52	18.51	6.54	19.28	*6.87*	*20.27*	7.05	20.81	*7.42*	*21.91*	7.83	23.13	*8.24*	*24.36*
45,000,000	18.83	18.76	6.63	19.55	*6.98*	*20.60*	7.16	21.13	*7.53*	*22.24*	7.95	23.49	*8.36*	*24.72*
50,000,000	19.10	18.98	6.72	19.82	*7.07*	*20.87*	7.25	21.40	*7.63*	*22.54*	8.05	23.79	*8.46*	*25.01*
75,000,000	20.20	19.85	7.07	20.87	*7.43*	*21.94*	7.63	22.54	*8.02*	*23.70*	8.46	25.01	*8.89*	*26.30*
100,000,000	21.00	20.46	7.32	21.61	*7.70*	*22.75*	7.90	23.34	*8.30*	*24.54*	8.77	25.94	*9.21*	*27.25*

CBR = 11 Mr = 4897 %REL = 90	AC=75%		1986 AASHTO DESIGN METHOD											
	KY DESIGN THICKNESS, IN		Pt = 2.0				Pt = 2.5				Pt = 3.0			
			DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	1981	1987	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	6.89	5.79	2.77	8.03	*2.95*	*8.57*	2.85	8.27	*3.05*	*8.87*	2.99	8.69	*3.23*	*9.40*
250,000	8.08	7.65	3.19	9.28	*3.39*	*9.88*	3.32	9.67	*3.55*	*10.36*	3.56	10.39	*3.84*	*11.22*
500,000	9.10	9.06	3.53	10.30	*3.75*	*10.96*	3.72	10.87	*3.96*	*11.58*	4.05	11.85	*4.35*	*12.75*
750,000	9.75	9.90	3.75	10.96	*3.98*	*11.64*	3.96	11.58	*4.22*	*12.36*	4.35	12.75	*4.66*	*13.67*
1,000,000	10.23	10.49	3.91	11.43	*4.14*	*12.12*	4.15	12.15	*4.41*	*12.93*	4.57	13.40	*4.88*	*14.33*
2,500,000	11.90	12.40	4.45	13.04	*4.71*	*13.82*	4.76	13.97	*5.05*	*14.84*	5.28	15.52	*5.61*	*16.51*
5,000,000	13.29	13.86	4.89	14.36	*5.17*	*15.19*	5.26	15.46	*5.56*	*16.36*	5.84	17.19	*6.18*	*18.21*
7,500,000	14.15	14.71	5.17	15.19	*5.45*	*16.03*	5.56	16.36	*5.87*	*17.28*	6.18	18.21	*6.53*	*19.25*
10,000,000	14.78	15.32	5.37	15.79	*5.66*	*16.66*	5.78	17.01	*6.10*	*17.97*	6.43	18.96	*6.78*	*20.00*
15,000,000	15.71	16.19	5.66	16.66	*5.96*	*17.55*	6.10	17.97	*6.43*	*18.96*	6.78	20.00	*7.15*	*21.10*
20,000,000	16.39	16.80	5.87	17.28	*6.19*	*18.24*	6.33	18.66	*6.67*	*19.67*	7.04	20.78	*7.42*	*21.91*
25,000,000	16.93	17.28	6.04	17.79	*6.36*	*18.75*	6.52	19.22	*6.87*	*20.27*	7.25	21.40	*7.63*	*22.54*
30,000,000	17.38	17.67	6.19	18.24	*6.51*	*19.19*	6.67	19.67	*7.03*	*20.75*	7.42	21.91	*7.80*	*23.04*
35,000,000	17.77	18.00	6.31	18.60	*6.64*	*19.58*	6.81	20.09	*7.17*	*21.16*	7.56	22.33	*7.96*	*23.52*
40,000,000	18.11	18.29	6.42	18.93	*6.75*	*19.91*	6.92	20.42	*7.29*	*21.52*	7.69	22.72	*8.09*	*23.91*
45,000,000	18.41	18.55	6.51	19.19	*6.85*	*20.21*	7.03	20.75	*7.39*	*21.82*	7.80	23.04	*8.21*	*24.27*
50,000,000	18.69	18.78	6.60	19.46	*6.94*	*20.48*	7.12	21.01	*7.49*	*22.12*	7.91	23.37	*8.31*	*24.57*
75,000,000	19.76	19.65	6.94	20.48	*7.30*	*21.55*	7.49	22.12	*7.88*	*23.28*	8.31	24.57	*8.74*	*25.85*
100,000,000	20.55	20.28	7.19	21.22	*7.56*	*22.33*	7.76	22.93	*8.16*	*24.12*	8.61	25.46	*9.05*	*26.78*

FIGURE E16. THICKNESS DESIGNS FOR 100% AC, 0% CS, CBR 2 AND CBR 3.

CBR = 2 Mr = 1591 %REL = 90	100% AC	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1981	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	8.55	4.08	10.00	4.32	10.60	4.35	10.68	4.62	11.35	4.80	11.80	5.12	12.60
250,000	9.81	4.64	11.40	4.91	12.08	4.98	12.25	5.27	12.98	5.53	13.63	5.86	14.45
500,000	10.86	5.10	12.55	5.38	13.25	5.48	13.50	5.80	14.30	6.10	15.05	6.44	15.90
750,000	11.51	5.38	13.25	5.67	13.98	5.80	14.30	6.12	15.10	6.44	15.90	6.80	16.80
1,000,000	11.99	5.59	13.78	5.89	14.53	6.02	14.85	6.35	15.68	6.69	16.53	7.06	17.45
2,500,000	13.61	6.28	15.50	6.61	16.33	6.78	16.75	7.14	17.65	7.53	18.63	7.92	19.60
5,000,000	14.93	6.86	16.95	7.21	17.83	7.40	18.30	7.78	19.25	8.21	20.33	8.63	21.38
7,500,000	15.74	7.21	17.83	7.58	18.75	7.78	19.25	8.18	20.25	8.63	21.38	9.07	22.48
10,000,000	16.33	7.47	18.48	7.85	19.43	8.06	19.95	8.47	20.98	8.94	22.15	9.39	23.28
15,000,000	17.19	7.85	19.43	8.24	20.40	8.47	20.98	8.89	22.03	9.39	23.28	9.85	24.43
20,000,000	17.81	8.12	20.10	8.53	21.13	8.77	21.73	9.20	22.80	9.72	24.10	10.20	25.30
25,000,000	18.31	8.35	20.68	8.76	21.70	9.00	22.30	9.45	23.43	9.98	24.75	10.47	25.98
30,000,000	18.72	8.53	21.13	8.96	22.20	9.20	22.80	9.66	23.95	10.20	25.30	10.70	26.55
35,000,000	19.07	8.69	21.53	9.12	22.60	9.37	23.23	9.84	24.40	10.38	25.75	10.89	27.03
40,000,000	19.38	8.83	21.88	9.27	22.98	9.52	23.60	10.00	24.80	10.55	26.18	11.07	27.48
45,000,000	19.65	8.96	22.20	9.40	23.30	9.66	23.95	10.13	25.13	10.70	26.55	11.22	27.85
50,000,000	19.90	9.07	22.48	9.52	23.60	9.78	24.25	10.26	25.45	10.83	26.88	11.36	28.20
75,000,000	20.87	9.52	23.60	9.98	24.75	10.26	25.45	10.76	26.70	11.36	28.20	11.91	29.58
100,000,000	21.57	9.85	24.43	10.33	25.63	10.62	26.35	11.13	27.63	11.75	29.18	12.31	30.58

CBR = 3 Mr = 2092 %REL = 90	100% AC	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1981	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	7.94	3.73	9.13	3.96	9.70	3.95	9.68	4.21	10.33	4.33	10.63	4.64	11.40
250,000	9.15	4.26	10.45	4.51	11.08	4.55	11.18	4.83	11.88	5.03	12.38	5.35	13.18
500,000	10.16	4.69	11.53	4.95	12.18	5.03	12.38	5.32	13.10	5.59	13.78	5.92	14.60
750,000	10.78	4.95	12.18	5.23	12.88	5.32	13.10	5.63	13.88	5.92	14.60	6.26	15.45
1,000,000	11.24	5.15	12.68	5.43	13.38	5.54	13.65	5.85	14.43	6.16	15.20	6.50	16.05
2,500,000	12.78	5.81	14.33	6.11	15.08	6.26	15.45	6.60	16.30	6.96	17.20	7.33	18.13
5,000,000	14.04	6.34	15.65	6.67	16.48	6.84	16.90	7.20	17.80	7.60	18.80	8.00	19.80
7,500,000	14.81	6.67	16.48	7.02	17.35	7.20	17.80	7.58	18.75	8.00	19.80	8.41	20.83
10,000,000	15.38	6.92	17.10	7.27	17.98	7.47	18.48	7.85	19.43	8.29	20.53	8.71	21.58
15,000,000	16.19	7.27	17.98	7.64	18.90	7.85	19.43	8.25	20.43	8.71	21.58	9.15	22.68
20,000,000	16.79	7.53	18.63	7.92	19.60	8.13	20.13	8.54	21.15	9.02	22.35	9.47	23.48
25,000,000	17.26	7.74	19.15	8.13	20.13	8.35	20.68	8.77	21.73	9.26	22.95	9.73	24.13
30,000,000	17.65	7.92	19.60	8.31	20.58	8.54	21.15	8.97	22.23	9.47	23.48	9.94	24.65
35,000,000	17.99	8.06	19.95	8.47	20.98	8.70	21.55	9.14	22.65	9.65	23.93	10.12	25.10
40,000,000	18.28	8.20	20.30	8.61	21.33	8.84	21.90	9.28	23.00	9.80	24.30	10.28	25.50
45,000,000	18.54	8.31	20.58	8.73	21.63	8.97	22.23	9.41	23.33	9.94	24.65	10.43	25.88
50,000,000	18.77	8.42	20.85	8.84	21.90	9.08	22.50	9.53	23.63	10.06	24.95	10.56	26.20
75,000,000	19.69	8.84	21.90	9.28	23.00	9.53	23.63	10.00	24.80	10.56	26.20	11.08	27.50
100,000,000	20.36	9.15	22.68	9.60	23.80	9.87	24.48	10.35	25.68	10.92	27.10	11.45	28.43

FIGURE E17. THICKNESS DESIGNS FOR 100% AC, 0% CS, CBR 4 AND CBR 5.

CBR = 4 Mr = 2513 %REL = 90	100% AC	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	KY DESIGN THICKNESS, IN 1981	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	7.42	3.50	8.55	3.72	9.10	3.68	9.00	3.93	9.63	4.00	9.80	4.31	10.58
250,000	8.60	4.00	9.80	4.24	10.40	4.25	10.43	4.52	11.10	4.69	11.53	5.01	12.33
500,000	9.58	4.41	10.83	4.67	11.48	4.72	11.60	5.01	12.33	5.23	12.88	5.56	13.70
750,000	10.19	4.67	11.48	4.93	12.13	5.01	12.33	5.30	13.05	5.56	13.70	5.89	14.53
1,000,000	10.64	4.85	11.93	5.13	12.63	5.21	12.83	5.51	13.58	5.79	14.28	6.13	15.13
2,500,000	12.16	5.48	13.50	5.78	14.25	5.91	14.58	6.23	15.38	6.57	16.23	6.93	17.13
5,000,000	13.41	6.00	14.80	6.31	15.58	6.47	15.98	6.81	16.83	7.19	17.78	7.57	18.73
7,500,000	14.17	6.31	15.58	6.65	16.43	6.81	16.83	7.17	17.73	7.57	18.73	7.96	19.70
10,000,000	14.73	6.55	16.18	6.89	17.03	7.07	17.48	7.43	18.38	7.85	19.43	8.25	20.43
15,000,000	15.55	6.89	17.03	7.24	17.90	7.43	18.38	7.82	19.35	8.25	20.43	8.67	21.48
20,000,000	16.14	7.14	17.65	7.50	18.55	7.70	19.05	8.10	20.05	8.55	21.18	8.98	22.25
25,000,000	16.61	7.34	18.15	7.71	19.08	7.92	19.60	8.21	20.33	8.78	21.75	9.22	22.85
30,000,000	17.00	7.50	18.55	7.88	19.50	8.10	20.05	8.51	21.08	8.98	22.25	9.43	23.38
35,000,000	17.33	7.64	18.90	8.03	19.87	8.25	20.43	8.67	21.48	9.15	22.68	9.61	23.83
40,000,000	17.63	7.77	19.23	8.16	20.20	8.39	20.78	8.81	21.83	9.30	23.05	9.76	24.20
45,000,000	17.89	7.88	19.50	8.28	20.50	8.51	21.08	8.93	22.13	9.43	23.38	9.90	24.55
50,000,000	18.12	7.98	19.75	8.38	20.75	8.61	21.33	9.05	22.43	9.55	23.68	10.02	24.85
75,000,000	19.04	8.38	20.75	8.80	21.80	9.05	22.43	9.50	23.55	10.02	24.85	10.52	26.10
100,000,000	19.71	8.68	21.50	9.11	22.58	9.36	23.20	9.82	24.35	10.37	25.73	10.88	27.00

CBR = 5 Mr = 2911 %REL = 90	100% AC	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)		DESIGN EALS		1.5(DESIGN EALS)	
DESIGN EALS	KY DESIGN THICKNESS, IN 1981	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES	SN	INCHES
100,000	7.07	3.33	8.13	3.53	8.63	3.48	8.50	3.72	9.10	3.76	9.20	4.05	9.93
250,000	8.23	3.81	9.33	5.45	13.43	4.03	9.88	4.30	10.55	4.43	10.88	4.74	11.65
500,000	9.19	4.21	10.33	4.45	10.93	4.49	11.03	4.76	11.70	4.97	12.23	5.29	13.03
750,000	9.79	4.45	10.93	4.71	11.58	4.76	11.70	5.05	12.43	5.29	13.03	5.61	13.83
1,000,000	10.22	4.63	11.38	4.90	12.05	4.97	12.23	5.26	12.95	5.52	13.60	5.85	14.43
2,500,000	11.71	5.24	12.90	5.53	13.63	5.64	13.90	5.96	14.70	6.27	15.48	6.62	16.35
5,000,000	12.92	5.74	14.15	6.05	14.93	6.19	15.28	6.52	16.10	6.88	17.00	7.25	17.93
7,500,000	13.66	6.05	14.93	6.37	15.73	6.52	16.10	6.87	16.98	7.25	17.93	7.63	18.88
10,000,000	14.20	6.27	15.48	6.60	16.30	6.77	16.73	7.12	17.60	7.52	18.60	7.91	19.58
15,000,000	14.99	6.60	16.30	6.94	17.15	7.12	17.60	7.49	18.52	7.91	19.58	8.32	20.60
20,000,000	15.56	6.84	16.90	7.19	17.78	7.38	18.25	7.76	19.20	8.20	20.30	8.61	21.33
25,000,000	16.01	7.03	17.38	7.39	18.28	7.59	18.78	7.98	19.75	8.42	20.85	8.85	21.93
30,000,000	16.39	7.19	17.78	7.56	18.70	7.76	19.20	8.16	20.20	8.61	21.33	9.05	22.43
35,000,000	16.71	7.33	18.13	7.71	19.08	7.91	19.58	8.31	20.58	8.78	21.75	9.22	22.85
40,000,000	16.99	7.45	18.43	7.83	19.37	8.04	19.90	8.45	20.93	8.92	22.10	9.37	23.23
45,000,000	17.24	7.56	18.70	7.94	19.65	8.16	20.20	8.57	21.23	9.05	22.43	9.50	23.55
50,000,000	17.47	7.66	18.95	8.05	19.93	8.27	20.48	8.68	21.50	9.17	22.73	9.62	23.85
75,000,000	18.35	8.05	19.93	8.45	20.93	8.68	21.50	9.12	22.60	9.62	23.85	10.10	25.05
100,000,000	19.00	8.33	20.63	8.75	21.68	8.99	22.28	9.43	23.38	9.96	24.70	10.45	25.93

FIGURE E18. THICKNESS DESIGNS FOR 100% AC, 0% CS, CBR 6 AND CBR 7.

CBR = 6, Mr = 3283, %REL = 90	100% AC	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1981	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*
100,000	6.76	3.19	7.78	*3.39*	*8.28*	3.32	8.10	*3.55*	*8.68*	3.57	8.73	*3.85*	*9.43*
250,000	7.90	3.66	8.95	*3.88*	*9.50*	3.86	9.45	*4.11*	*10.08*	4.22	10.35	*4.53*	*11.13*
500,000	8.85	4.04	9.90	*4.28*	*10.50*	4.30	10.55	*4.57*	*11.23*	4.75	11.68	*5.07*	*12.48*
750,000	9.44	4.28	10.50	*4.53*	*11.13*	4.57	11.23	*4.85*	*11.93*	5.07	12.48	*5.39*	*13.28*
1,000,000	9.87	4.46	10.95	*4.71*	*11.58*	4.77	11.73	*5.06*	*12.45*	5.29	13.03	*5.62*	*13.85*
2,500,000	11.33	5.05	12.43	*5.33*	*13.13*	5.43	13.38	*5.74*	*14.15*	6.04	14.90	*6.38*	*15.75*
5,000,000	12.52	5.54	13.65	*5.83*	*14.38*	5.96	14.70	*6.29*	*15.53*	6.63	16.38	*6.99*	*17.27*
7,500,000	13.24	5.83	14.38	*6.15*	*15.18*	6.29	15.53	*6.63*	*16.38*	6.99	17.27	*7.36*	*18.20*
10,000,000	13.77	6.05	14.93	*6.37*	*15.73*	6.53	16.13	*6.88*	*17.00*	7.25	17.93	*7.64*	*18.90*
15,000,000	14.54	6.37	15.73	*6.71*	*16.58*	6.88	17.00	*7.24*	*17.90*	7.64	18.90	*8.03*	*19.87*
20,000,000	15.10	6.61	16.33	*6.95*	*17.18*	7.13	17.63	*7.50*	*18.55*	7.92	19.60	*8.33*	*20.63*
25,000,000	15.54	6.80	16.80	*7.15*	*17.68*	7.33	18.13	*7.71*	*19.08*	8.14	20.15	*8.56*	*21.20*
30,000,000	15.91	6.95	17.18	*7.31*	*18.08*	7.50	18.55	*7.89*	*19.53*	8.33	20.63	*8.75*	*21.68*
35,000,000	16.23	7.08	17.50	*7.45*	*18.43*	7.65	18.93	*8.04*	*19.90*	8.48	21.00	*8.92*	*22.10*
40,000,000	16.50	7.20	17.80	*7.57*	*18.73*	7.77	19.23	*8.17*	*20.23*	8.62	21.35	*9.06*	*22.45*
45,000,000	16.75	7.31	18.08	*7.68*	*19.00*	7.89	19.53	*8.29*	*20.53*	8.75	21.68	*9.19*	*22.78*
50,000,000	16.97	7.40	18.30	*7.78*	*19.25*	7.99	19.77	*8.39*	*20.78*	8.86	21.95	*9.31*	*23.08*
75,000,000	17.83	7.78	19.25	*8.17*	*20.23*	8.39	20.78	*8.81*	*21.83*	9.31	23.08	*9.77*	*24.23*
100,000,000	18.46	8.05	19.93	*8.46*	*20.95*	8.69	21.53	*9.13*	*22.63*	9.63	23.88	*10.11*	*25.08*

CBR = 7, Mr = 3635, %REL = 90	100% AC	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1981	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*
100,000	6.45	3.08	7.50	*3.27*	*7.98*	3.20	7.80	*3.42*	*8.35*	3.41	8.33	*3.68*	*9.00*
250,000	7.59	3.53	8.63	*6.94*	*17.15*	3.71	9.08	*3.96*	*9.70*	4.05	9.93	*4.35*	*9.18*
500,000	8.53	3.91	9.58	*4.14*	*10.15*	4.15	10.18	*4.41*	*10.83*	4.57	11.23	*4.88*	*12.00*
750,000	9.12	4.14	10.15	*4.38*	*10.75*	4.41	10.83	*4.69*	*11.53*	4.88	12.00	*5.20*	*12.80*
1,000,000	9.54	4.31	10.58	*4.56*	*11.20*	4.61	11.33	*4.89*	*12.03*	5.11	12.58	*5.43*	*13.38*
2,500,000	10.99	4.89	12.03	*5.17*	*12.73*	5.26	12.95	*5.56*	*13.70*	5.84	14.40	*6.18*	*15.25*
5,000,000	12.17	5.37	13.23	*5.66*	*13.95*	5.78	14.25	*6.10*	*15.05*	6.43	15.88	*6.78*	*16.75*
7,500,000	12.89	5.66	13.95	*5.96*	*14.70*	6.10	15.05	*6.43*	*15.88*	6.78	16.75	*7.15*	*17.68*
10,000,000	13.41	5.87	14.48	*6.19*	*15.28*	6.33	15.63	*6.67*	*16.48*	7.04	17.40	*7.41*	*18.33*
15,000,000	14.17	6.19	15.28	*6.51*	*16.08*	6.67	16.48	*7.03*	*17.38*	7.41	18.33	*7.80*	*19.30*
20,000,000	14.73	6.41	15.83	*6.75*	*16.68*	6.92	17.10	*7.28*	*18.00*	7.69	19.03	*8.09*	*20.03*
25,000,000	15.17	6.60	16.30	*6.94*	*17.15*	7.12	17.60	*7.49*	*18.52*	7.90	19.55	*8.31*	*20.58*
30,000,000	15.53	6.75	16.68	*7.10*	*17.55*	7.28	18.00	*7.66*	*18.95*	8.09	20.03	*8.50*	*21.05*
35,000,000	15.84	6.88	17.00	*7.23*	*17.88*	7.43	18.38	*8.05*	*19.93*	8.24	20.40	*8.66*	*21.45*
40,000,000	16.12	6.99	17.27	*7.35*	*18.18*	7.55	18.68	*7.94*	*19.65*	8.38	20.75	*8.80*	*21.80*
45,000,000	16.36	7.10	17.55	*7.46*	*18.45*	7.66	18.95	*8.05*	*19.93*	8.50	21.05	*8.93*	*22.13*
50,000,000	16.58	7.19	17.78	*7.56*	*18.70*	7.76	19.20	*8.16*	*20.20*	8.61	21.33	*9.05*	*22.43*
75,000,000	17.44	7.56	18.70	*7.94*	*19.65*	8.16	20.20	*8.57*	*21.23*	9.05	22.43	*9.50*	*23.55*
100,000,000	18.06	7.83	19.37	*8.22*	*20.35*	8.45	20.93	*8.87*	*21.98*	9.36	23.20	*9.83*	*24.38*

FIGURE E19. THICKNESS DESIGNS FOR 100% AC, 0% CS, CBR 8 AND CBR 9.

CBR = 8 Mr = 3969 %REL = 90	100% AC	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1981	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	6.23	2.99	7.28	3.17	7.73	3.09	7.53	3.31	8.08	3.20	7.80	3.54	8.65
250,000	7.37	3.43	8.38	3.64	8.90	3.59	8.78	3.84	9.40	3.90	9.55	4.20	10.30
500,000	8.31	3.79	9.28	4.02	9.85	4.02	9.85	4.28	10.50	4.41	10.83	4.72	11.60
750,000	8.89	4.02	9.85	4.26	10.45	4.28	10.50	4.55	11.18	4.72	11.60	5.04	12.40
1,000,000	9.32	4.19	10.28	4.44	10.90	4.47	10.98	4.75	11.68	4.95	12.18	5.27	12.98
2,500,000	10.75	4.76	11.70	5.03	12.38	5.11	12.58	5.41	13.33	5.68	14.00	6.01	14.83
5,000,000	11.91	5.22	12.85	5.51	13.58	5.62	13.85	5.94	14.65	6.25	15.43	6.60	16.30
7,500,000	12.62	5.51	13.58	5.81	14.33	5.94	14.65	6.26	15.45	6.60	16.30	6.96	17.20
10,000,000	13.14	5.72	14.10	6.03	14.88	6.17	15.23	6.50	16.05	6.85	16.93	7.22	17.85
15,000,000	13.88	6.03	14.88	6.35	15.68	6.50	16.05	6.85	16.93	7.22	17.85	7.60	18.80
20,000,000	14.43	6.25	15.43	6.58	16.25	6.74	16.65	7.10	17.55	7.49	18.52	7.88	19.50
25,000,000	14.86	6.43	15.88	6.77	16.73	6.94	17.15	7.30	18.05	7.71	19.08	8.11	20.08
30,000,000	15.22	6.58	16.25	6.92	17.10	7.10	17.55	7.47	18.48	7.88	19.50	8.29	20.53
35,000,000	15.52	6.71	16.58	7.05	17.43	7.24	17.90	7.61	18.83	8.04	19.90	8.45	20.93
40,000,000	15.79	6.82	16.85	7.17	17.73	7.36	18.20	7.74	19.15	8.17	20.23	8.59	21.28
45,000,000	16.03	6.92	17.10	7.28	18.00	7.47	18.48	7.85	19.43	8.29	20.53	8.71	21.58
50,000,000	16.24	7.01	17.33	7.37	18.23	7.57	18.73	7.95	19.68	8.40	20.80	8.83	21.88
75,000,000	17.08	7.37	18.23	7.75	19.18	7.95	19.68	8.36	20.70	8.83	21.88	9.27	22.98
100,000,000	17.69	7.64	18.90	8.02	19.85	8.24	20.40	8.66	21.45	9.14	22.65	9.59	23.78

CBR = 9 Mr = 4290 %REL = 90	100% AC	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	5.96	2.90	7.05	3.09	7.53	3.00	7.30	3.21	7.83	3.17	7.73	3.42	8.35
250,000	7.09	3.34	8.15	3.54	8.65	3.49	8.53	3.73	9.13	3.77	9.23	4.06	9.95
500,000	8.02	3.70	9.05	3.92	9.60	3.90	9.55	4.16	10.20	4.28	10.50	4.58	11.25
750,000	8.59	3.92	9.60	4.15	10.18	4.16	10.20	4.43	10.88	4.58	11.25	4.90	12.05
1,000,000	9.01	4.08	10.00	4.33	10.63	4.35	10.68	4.62	11.35	4.81	11.83	5.12	12.60
2,500,000	10.43	4.64	11.40	4.91	12.08	4.98	12.25	5.27	12.98	5.53	13.63	5.86	14.45
5,000,000	11.57	5.10	12.55	5.38	13.25	5.49	13.53	5.80	14.30	6.10	15.05	6.44	15.90
7,500,000	12.27	5.38	13.25	5.67	13.98	5.80	14.30	6.12	15.10	6.44	15.90	6.80	16.80
10,000,000	12.78	5.59	13.78	5.89	14.53	6.02	14.85	6.35	15.68	6.69	16.53	7.06	17.45
15,000,000	13.52	5.89	14.53	6.20	15.30	6.35	15.68	6.69	16.53	7.06	17.45	7.43	18.38
20,000,000	14.06	6.11	15.08	6.43	15.88	6.59	16.28	6.94	17.15	7.32	18.10	7.71	19.08
25,000,000	14.49	6.28	15.50	6.61	16.33	6.78	16.75	7.14	17.65	7.53	18.63	7.93	19.63
30,000,000	14.84	6.43	15.88	6.77	16.73	6.94	17.15	7.30	18.05	7.71	19.08	8.11	20.08
35,000,000	15.14	6.56	16.20	6.90	17.05	7.08	17.50	7.45	18.43	7.86	19.45	8.26	20.45
40,000,000	15.40	6.67	16.48	7.01	17.33	7.20	17.80	7.57	18.73	7.99	19.77	8.40	20.80
45,000,000	15.64	6.77	16.73	7.12	17.60	7.30	18.05	7.68	19.00	8.11	20.08	8.52	21.10
50,000,000	15.85	6.86	16.95	7.21	17.83	7.40	18.30	7.78	19.25	8.21	20.33	8.63	21.38
75,000,000	16.68	7.21	17.83	7.58	18.75	7.78	19.25	8.18	20.25	8.63	21.38	9.07	22.48
100,000,000	17.28	7.47	18.48	7.85	19.43	8.06	19.95	8.47	20.98	8.94	22.15	9.39	23.28

FIGURE E20. THICKNESS DESIGNS FOR 100% AC, 0% CS, CBR 10 AND CBR 11.

CBR = 10 Mr = 4598 %REL = 90	100% AC	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1981	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	5.76	2.83	6.88	3.02	7.35	2.92	7.10	3.12	7.60	3.07	7.48	3.32	6.70
250,000	6.88	3.26	7.95	3.46	8.45	3.40	8.30	3.63	8.88	3.66	8.95	3.95	8.28
500,000	7.80	3.61	8.82	3.83	9.38	3.80	9.30	4.06	9.95	4.16	10.20	4.46	9.55
750,000	8.37	3.83	9.38	4.06	9.95	4.06	9.95	4.32	10.60	4.46	10.95	4.77	10.33
1,000,000	8.79	3.99	9.78	4.23	10.38	4.24	10.40	4.51	11.08	4.68	11.50	5.00	10.90
2,500,000	10.19	4.54	11.15	4.80	11.80	4.86	11.95	5.16	12.70	5.40	13.30	5.73	12.73
5,000,000	11.32	4.99	12.28	5.27	12.98	5.37	13.23	5.67	13.98	5.96	14.70	6.30	14.15
7,500,000	12.02	5.27	12.98	5.56	13.70	5.67	13.98	5.99	14.78	6.30	15.55	6.66	15.05
10,000,000	12.52	5.47	13.48	5.77	14.23	5.89	14.53	6.22	15.35	6.55	16.18	6.91	15.68
15,000,000	13.25	5.77	14.23	6.08	15.00	6.22	15.35	6.55	16.18	6.91	17.08	7.28	16.60
20,000,000	13.78	5.99	14.78	6.30	15.55	6.46	15.95	6.80	16.80	7.17	17.73	7.55	17.28
25,000,000	14.20	6.16	15.20	6.48	16.00	6.64	16.40	6.99	17.27	7.38	18.25	7.77	17.83
30,000,000	14.55	6.30	15.55	6.63	16.38	6.80	16.80	7.16	17.70	7.55	18.68	7.95	18.28
35,000,000	14.85	6.43	15.88	6.76	16.70	6.93	17.13	7.30	18.05	7.70	19.05	8.10	18.65
40,000,000	15.11	6.54	16.15	6.87	16.98	7.05	17.43	7.42	18.35	7.83	19.37	8.24	19.00
45,000,000	15.34	6.63	16.38	6.98	17.25	7.16	17.70	7.53	18.63	7.95	19.68	8.36	19.30
50,000,000	15.55	6.72	16.60	7.07	17.48	7.25	17.93	7.63	18.88	8.05	19.93	8.46	19.55
75,000,000	16.36	7.07	17.48	7.43	18.38	7.63	18.88	8.02	19.85	8.46	20.95	8.89	20.63
100,000,000	16.96	7.32	18.10	7.70	19.05	7.90	19.55	8.30	20.55	8.77	21.73	9.21	21.43

CBR = 11 Mr = 4897 %REL = 90	100% AC	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1981	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	5.56	2.77	6.73	2.95	7.18	2.85	6.93	3.05	7.43	2.99	7.28	3.23	7.88
250,000	6.68	3.19	7.78	3.39	8.28	3.32	8.10	3.55	8.68	3.56	8.70	3.84	9.40
500,000	7.60	3.53	8.63	3.75	9.18	3.72	9.10	3.96	9.70	4.05	9.93	4.35	10.68
750,000	8.17	3.75	9.18	3.98	9.75	3.96	9.70	4.22	10.35	4.35	10.68	4.66	11.45
1,000,000	8.58	3.91	9.58	4.14	10.15	4.15	10.18	4.41	10.83	4.57	11.23	4.88	12.00
2,500,000	9.97	4.45	10.93	4.71	11.58	4.76	11.70	5.05	12.43	5.28	13.00	5.61	13.83
5,000,000	11.09	4.89	12.03	5.17	12.73	5.26	12.95	5.56	13.70	5.84	14.40	6.18	15.25
7,500,000	11.77	5.17	12.73	5.45	13.43	5.56	13.70	5.87	14.48	6.18	15.25	6.53	16.13
10,000,000	12.27	5.37	13.23	5.66	13.95	5.78	14.25	6.10	15.05	6.43	15.88	6.78	16.75
15,000,000	12.99	5.66	13.95	5.96	14.70	6.10	15.05	6.43	15.88	6.78	16.75	7.15	17.68
20,000,000	13.51	5.87	14.48	6.19	15.28	6.33	15.63	6.67	16.48	7.04	17.40	7.42	18.35
25,000,000	13.93	6.04	14.90	6.36	15.70	6.52	16.10	6.87	16.98	7.25	17.93	7.63	18.88
30,000,000	14.27	6.19	15.28	6.51	16.08	6.67	16.48	7.03	17.38	7.42	18.35	7.80	19.30
35,000,000	14.56	6.31	15.58	6.64	16.40	6.81	16.83	7.17	17.73	7.56	18.70	7.96	19.70
40,000,000	14.82	6.42	15.85	6.75	16.68	6.92	17.10	7.29	18.02	7.69	19.03	8.09	20.03
45,000,000	15.04	6.51	16.08	6.85	16.93	7.03	17.38	7.39	18.28	7.80	19.30	8.21	20.33
50,000,000	15.25	6.60	16.30	6.94	17.15	7.12	17.60	7.49	18.52	7.91	19.58	8.31	20.58
75,000,000	16.05	6.94	17.15	7.30	18.05	7.49	18.52	7.88	19.50	8.31	20.58	8.74	21.65
100,000,000	16.63	7.19	17.78	7.56	18.70	7.76	19.20	8.16	20.20	8.61	21.33	9.05	22.43

FIGURE E21. THICKNESS DESIGNS FOR 4-INCH CS, CBR 2 AND CBR 3.

CBR = 2 Mr = 1591 %REL = 90	4" CS	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*
100,000	19.66	4.08	12.60	*4.32*	*13.20*	4.35	13.28	*4.62*	*13.95*	4.80	14.40	*5.12*	*15.20*
250,000	23.08	4.64	14.00	*4.91*	*14.68*	4.98	14.85	*5.27*	*15.58*	5.53	16.23	*5.86*	*17.05*
500,000	25.70	5.10	15.15	*5.38*	*15.85*	5.48	16.10	*5.80*	*16.90*	6.10	17.65	*6.44*	*18.50*
750,000	27.24	5.38	15.85	*5.67*	*16.58*	5.80	16.90	*6.12*	*17.70*	6.44	18.50	*6.80*	*19.40*
1,000,000	28.33	5.59	16.38	*5.89*	*17.13*	6.02	17.45	*6.35*	*18.27*	6.69	19.13	*7.06*	*20.05*
2,500,000	31.86	6.28	18.10	*6.61*	*18.93*	6.78	19.35	*7.14*	*20.25*	7.53	21.23	*7.92*	*22.20*
5,000,000	34.54	6.86	19.55	*7.21*	*20.43*	7.40	20.90	*7.78*	*21.85*	8.21	22.93	*8.63*	*23.98*
7,500,000	36.13	7.21	20.43	*7.58*	*21.35*	7.78	21.85	*8.18*	*22.85*	8.63	23.98	*9.07*	*25.08*
10,000,000	37.26	7.47	21.08	*7.85*	*22.03*	8.06	22.55	*8.47*	*23.58*	8.94	24.75	*9.39*	*25.88*
15,000,000	38.85	7.85	22.03	*8.24*	*23.00*	8.47	23.58	*8.89*	*24.63*	9.39	25.88	*9.85*	*27.03*
20,000,000	39.99	8.12	22.70	*8.53*	*23.73*	8.77	24.33	*9.20*	*25.40*	9.72	26.70	*10.20*	*27.90*
25,000,000	40.87	8.35	23.28	*8.76*	*24.30*	9.00	24.90	*9.45*	*26.03*	9.98	27.35	*10.47*	*28.58*
30,000,000	41.60	8.53	23.73	*8.96*	*24.80*	9.20	25.40	*9.66*	*26.55*	10.20	27.90	*10.70*	*29.15*
35,000,000	42.21	8.69	24.13	*9.12*	*25.20*	9.37	25.83	*9.84*	*27.00*	10.38	28.35	*10.89*	*29.63*
40,000,000	42.74	8.83	24.48	*9.27*	*25.58*	9.52	26.20	*10.00*	*27.40*	10.55	28.78	*11.07*	*30.08*
45,000,000	43.21	8.96	24.80	*9.40*	*25.90*	9.66	26.55	*10.13*	*27.73*	10.70	29.15	*11.22*	*30.45*
50,000,000	43.64	9.07	25.08	*9.52*	*26.20*	9.78	26.85	*10.26*	*28.05*	10.83	29.48	*11.36*	*30.80*
75,000,000	45.26	9.52	26.20	*9.98*	*27.35*	10.26	28.05	*10.76*	*29.30*	11.36	30.80	*11.91*	*32.18*
100,000,000	46.42	9.85	27.03	*10.33*	*28.23*	10.62	28.95	*11.13*	*30.23*	11.75	31.78	*12.31*	*33.18*

CBR = 3 Mr = 2092 %REL = 90	4" CS	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*
100,000	17.55	3.73	11.73	*3.96*	*12.30*	3.95	12.28	*4.21*	*12.93*	4.33	13.23	*4.64*	*14.00*
250,000	20.31	4.26	13.05	*4.51*	*13.68*	4.55	13.78	*4.83*	*14.48*	5.03	14.98	*5.35*	*15.78*
500,000	22.46	4.69	14.13	*4.95*	*14.78*	5.03	14.98	*5.32*	*15.70*	5.59	16.38	*5.92*	*17.20*
750,000	23.75	4.95	14.78	*5.23*	*15.48*	5.32	15.70	*5.63*	*16.48*	5.92	17.20	*6.26*	*18.05*
1,000,000	24.68	5.15	15.28	*5.43*	*15.98*	5.54	16.25	*5.85*	*17.02*	6.16	17.80	*6.50*	*18.65*
2,500,000	27.70	5.81	16.93	*6.11*	*17.68*	6.26	18.05	*6.60*	*18.90*	6.96	19.80	*7.33*	*20.73*
5,000,000	30.05	6.34	18.25	*6.67*	*19.08*	6.84	19.50	*7.20*	*20.40*	7.60	21.40	*8.00*	*22.40*
7,500,000	31.46	6.67	19.08	*7.02*	*19.95*	7.20	20.40	*7.58*	*21.35*	8.00	22.40	*8.41*	*23.43*
10,000,000	32.47	6.92	19.70	*7.27*	*20.58*	7.47	21.08	*7.85*	*22.03*	8.29	23.13	*8.71*	*24.18*
15,000,000	33.91	7.27	20.58	*7.64*	*21.50*	7.85	22.03	*8.25*	*23.03*	8.71	24.18	*9.15*	*25.28*
20,000,000	34.95	7.53	21.23	*7.92*	*22.20*	8.13	22.73	*8.54*	*23.75*	9.02	24.95	*9.47*	*26.08*
25,000,000	35.76	7.74	21.75	*8.13*	*22.73*	8.35	23.28	*8.77*	*24.33*	9.26	25.55	*9.73*	*26.73*
30,000,000	36.43	7.92	22.20	*8.31*	*23.18*	8.54	23.75	*8.97*	*24.83*	9.47	26.08	*9.94*	*27.25*
35,000,000	37.00	8.06	22.55	*8.47*	*23.58*	8.70	24.15	*9.14*	*25.25*	9.65	26.53	*10.12*	*27.70*
40,000,000	37.49	8.20	22.90	*8.61*	*23.93*	8.84	24.50	*9.28*	*25.60*	9.80	26.90	*10.28*	*28.10*
45,000,000	37.93	8.31	23.18	*8.73*	*24.23*	8.97	24.83	*9.41*	*25.93*	9.94	27.25	*10.43*	*28.48*
50,000,000	38.32	8.42	23.45	*8.84*	*24.50*	9.08	25.10	*9.53*	*26.23*	10.06	27.55	*10.56*	*28.80*
75,000,000	39.84	8.84	24.50	*9.28*	*25.60*	9.53	26.23	*10.00*	*27.40*	10.56	28.80	*11.08*	*30.10*
100,000,000	40.94	9.15	25.28	*9.60*	*26.40*	9.87	27.08	*10.35*	*28.28*	10.92	29.70	*11.45*	*31.03*

FIGURE E22. THICKNESS DESIGNS FOR 4-INCH CS, CBR 4 AND CBR 5.

CBR = 4 Mr = 2513 %REL = 90	4" CS	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	10.91	3.50	11.15	3.72	11.70	3.68	11.60	3.93	12.23	4.00	12.40	4.31	13.18
250,000	12.15	4.00	12.40	4.24	13.00	4.25	13.03	4.52	13.70	4.69	14.13	5.01	14.93
500,000	13.13	4.41	13.43	4.67	14.08	4.72	14.20	5.01	14.93	5.23	15.48	5.56	16.30
750,000	13.72	4.67	14.08	4.93	14.73	5.01	14.93	5.30	15.65	5.56	16.30	5.89	17.13
1,000,000	14.15	4.85	14.53	5.13	15.23	5.21	15.43	5.51	16.18	5.79	16.88	6.13	17.73
2,500,000	15.55	5.48	16.10	5.78	16.85	5.91	17.18	6.23	17.98	6.57	18.83	6.93	19.73
5,000,000	16.65	6.00	17.40	6.31	18.18	6.47	18.58	6.81	19.43	7.19	20.38	7.57	21.33
7,500,000	17.32	6.31	18.18	6.65	19.03	6.81	19.43	7.17	20.33	7.57	21.33	7.96	22.30
10,000,000	17.80	6.55	18.78	6.89	19.63	7.07	20.08	7.43	20.98	7.85	22.03	8.25	23.03
15,000,000	18.48	6.89	19.63	7.24	20.50	7.43	20.98	7.82	21.95	8.25	23.03	8.67	24.08
20,000,000	18.98	7.14	20.25	7.50	21.15	7.70	21.65	8.10	22.65	8.55	23.78	8.98	24.85
25,000,000	19.36	7.34	20.75	7.71	21.68	7.92	22.20	8.21	22.93	8.78	24.35	9.22	25.45
30,000,000	19.68	7.50	21.15	7.88	22.10	8.10	22.65	8.51	23.68	8.98	24.85	9.43	25.98
35,000,000	19.96	7.64	21.50	8.03	22.48	8.25	23.03	8.67	24.08	9.15	25.28	9.61	26.43
40,000,000	20.19	7.77	21.83	8.16	22.80	8.39	23.38	8.81	24.43	9.30	25.65	9.76	26.80
45,000,000	20.40	7.88	22.10	8.28	23.10	8.51	23.68	8.93	24.73	9.43	25.98	9.90	27.15
50,000,000	20.59	7.98	22.35	8.38	23.35	8.61	23.93	9.05	25.03	9.55	26.28	10.02	27.45
75,000,000	21.33	8.38	23.35	8.80	24.40	9.05	25.03	9.50	26.15	10.02	27.45	10.52	28.70
100,000,000	21.86	8.68	24.10	9.11	25.18	9.36	25.80	9.82	26.95	10.37	28.33	10.88	29.60

CBR = 5 Mr = 2911 %REL = 90	4" CS	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	10.50	3.33	10.73	3.53	11.23	3.48	11.10	3.72	11.70	3.76	11.80	4.05	12.53
250,000	11.69	3.81	11.93	5.45	16.03	4.03	12.48	4.30	13.15	4.43	13.48	4.74	14.25
500,000	12.63	4.21	12.93	4.45	13.53	4.49	13.63	4.76	14.30	4.97	14.83	5.29	15.63
750,000	13.21	4.45	13.53	4.71	14.18	4.76	14.30	5.05	15.03	5.29	15.63	5.61	16.43
1,000,000	13.62	4.63	13.98	4.90	14.65	4.97	14.83	5.26	15.55	5.52	16.20	5.85	17.02
2,500,000	15.00	5.24	15.50	5.53	16.23	5.64	16.50	5.96	17.30	6.27	18.08	6.62	18.95
5,000,000	16.09	5.74	16.75	6.05	17.53	6.19	17.88	6.52	18.70	6.88	19.60	7.25	20.53
7,500,000	16.75	6.05	17.53	6.37	18.33	6.52	18.70	6.87	19.58	7.25	20.53	7.63	21.48
10,000,000	17.23	6.27	18.08	6.60	18.90	6.77	19.33	7.12	20.20	7.52	21.20	7.91	22.18
15,000,000	17.92	6.60	18.90	6.94	19.75	7.12	20.20	7.49	21.13	7.91	22.18	8.32	23.20
20,000,000	18.41	6.84	19.50	7.19	20.38	7.38	20.85	7.76	21.80	8.20	22.90	8.61	23.93
25,000,000	18.80	7.03	19.98	7.39	20.88	7.59	21.38	7.98	22.35	8.42	23.45	8.85	24.53
30,000,000	19.13	7.19	20.38	7.56	21.30	7.76	21.80	8.16	22.80	8.61	23.93	9.05	25.03
35,000,000	19.40	7.33	20.73	7.71	21.68	7.91	22.18	8.31	23.18	8.78	24.35	9.22	25.45
40,000,000	19.64	7.45	21.03	7.83	21.98	8.04	22.50	8.45	23.53	8.92	24.70	9.37	25.83
45,000,000	19.85	7.56	21.30	7.94	22.25	8.16	22.80	8.57	23.83	9.05	25.03	9.50	26.15
50,000,000	20.04	7.66	21.55	8.05	22.53	8.27	23.08	8.68	24.10	9.17	25.33	9.62	26.45
75,000,000	20.79	8.05	22.53	8.45	23.53	8.68	24.10	9.12	25.20	9.62	26.45	10.10	27.65
100,000,000	21.33	8.33	23.23	8.75	24.28	8.99	24.88	9.43	25.98	9.96	27.30	10.45	28.53

FIGURE E23. THICKNESS DESIGNS FOR 4-INCH CS, CBR 6 AND CBR 7.

CBR = 6 Mr = 3283 %REL = 90	4" CS	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	10.19	3.19	9.98	*3.39*	*10.43*	3.32	10.27	*3.55*	*10.80*	3.57	10.84	*3.85*	*11.48*
250,000	11.31	3.66	11.05	*3.88*	*11.55*	3.86	11.50	*4.11*	*12.07*	4.22	12.32	*4.53*	*13.02*
500,000	12.22	4.04	11.91	*4.28*	*12.45*	4.30	12.50	*4.57*	*13.11*	4.75	13.52	*5.07*	*14.25*
750,000	12.77	4.28	12.45	*4.53*	*13.02*	4.57	13.11	*4.85*	*13.75*	5.07	14.25	*5.39*	*14.98*
1,000,000	13.18	4.46	12.86	*4.71*	*13.43*	4.77	13.57	*5.06*	*14.23*	5.29	14.75	*5.62*	*15.50*
2,500,000	14.53	5.05	14.20	*5.33*	*14.84*	5.43	15.07	*5.74*	*15.77*	6.04	16.45	*6.38*	*17.23*
5,000,000	15.62	5.54	15.32	*5.83*	*15.98*	5.96	16.27	*6.29*	*17.02*	6.63	17.80	*6.99*	*18.61*
7,500,000	16.28	5.83	15.98	*6.15*	*16.70*	6.29	17.02	*6.63*	*17.80*	6.99	18.61	*7.36*	*19.45*
10,000,000	16.76	6.05	16.48	*6.37*	*17.20*	6.53	17.57	*6.88*	*18.36*	7.25	19.20	*7.64*	*20.09*
15,000,000	17.45	6.37	17.20	*6.71*	*17.98*	6.88	18.36	*7.24*	*19.18*	7.64	20.09	*8.03*	*20.98*
20,000,000	17.95	6.61	17.75	*6.95*	*18.52*	7.13	18.93	*7.50*	*19.77*	7.92	20.73	*8.33*	*21.66*
25,000,000	18.34	6.80	18.18	*7.15*	*18.98*	7.33	19.39	*7.71*	*20.25*	8.14	21.23	*8.56*	*22.18*
30,000,000	18.67	6.95	18.52	*7.31*	*19.34*	7.50	19.77	*7.89*	*20.66*	8.33	21.66	*8.75*	*22.61*
35,000,000	18.95	7.08	18.82	*7.45*	*19.66*	7.65	20.11	*8.04*	*21.00*	8.48	22.00	*8.92*	*23.00*
40,000,000	19.19	7.20	19.09	*7.57*	*19.93*	7.77	20.39	*8.17*	*21.30*	8.62	22.32	*9.06*	*23.32*
45,000,000	19.41	7.31	19.34	*7.68*	*20.18*	7.89	20.66	*8.29*	*21.57*	8.75	22.61	*9.19*	*23.61*
50,000,000	19.61	7.40	19.55	*7.78*	*20.41*	7.99	20.89	*8.39*	*21.80*	8.86	22.86	*9.31*	*23.89*
75,000,000	20.37	7.78	20.41	*8.17*	*21.30*	8.39	21.80	*8.81*	*22.75*	9.31	23.89	*9.77*	*24.93*
100,000,000	20.92	8.05	21.02	*8.46*	*21.95*	8.69	22.48	*9.13*	*23.48*	9.63	24.61	*10.11*	*25.70*

CBR = 7 Mr = 3635 %REL = 90	4" CS	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	9.88	3.08	10.10	*3.27*	*10.58*	3.20	10.40	*3.42*	*10.95*	3.41	10.93	*3.68*	*11.60*
250,000	10.98	3.53	11.23	*6.94*	*19.75*	3.71	11.68	*3.96*	*12.30*	4.05	12.53	*4.35*	*11.78*
500,000	11.88	3.91	12.18	*4.14*	*12.75*	4.15	12.78	*4.41*	*13.43*	4.57	13.83	*4.88*	*14.60*
750,000	12.43	4.14	12.75	*4.38*	*13.35*	4.41	13.43	*4.69*	*14.13*	4.88	14.60	*5.20*	*15.40*
1,000,000	12.83	4.31	13.18	*4.56*	*13.80*	4.61	13.93	*4.89*	*14.63*	5.11	15.18	*5.43*	*15.98*
2,500,000	14.17	4.89	14.63	*5.17*	*15.33*	5.26	15.55	*5.56*	*16.30*	5.84	17.00	*6.18*	*17.85*
5,000,000	15.24	5.37	15.83	*5.66*	*16.55*	5.78	16.85	*6.10*	*17.65*	6.43	18.48	*6.78*	*19.35*
7,500,000	15.90	5.66	16.55	*5.96*	*17.30*	6.10	17.65	*6.43*	*18.48*	6.78	19.35	*7.15*	*20.28*
10,000,000	16.38	5.87	17.08	*6.19*	*17.88*	6.33	18.23	*6.67*	*19.08*	7.04	20.00	*7.41*	*20.93*
15,000,000	17.06	6.19	17.88	*6.51*	*18.68*	6.67	19.08	*7.03*	*19.98*	7.41	20.93	*7.80*	*21.90*
20,000,000	17.56	6.41	18.43	*6.75*	*19.28*	6.92	19.70	*7.28*	*20.60*	7.69	21.63	*8.09*	*22.63*
25,000,000	17.96	6.60	18.90	*6.94*	*19.75*	7.12	20.20	*7.49*	*21.13*	7.90	22.15	*8.31*	*23.18*
30,000,000	18.28	6.75	19.28	*7.10*	*20.15*	7.28	20.60	*7.66*	*21.55*	8.09	22.63	*8.50*	*23.65*
35,000,000	18.56	6.88	19.60	*7.23*	*20.48*	7.43	20.98	*8.05*	*22.53*	8.24	23.00	*8.66*	*24.05*
40,000,000	18.81	6.99	19.88	*7.35*	*20.78*	7.55	21.28	*7.94*	*22.25*	8.38	23.35	*8.80*	*24.40*
45,000,000	19.02	7.10	20.15	*7.46*	*21.05*	7.66	21.55	*8.05*	*22.53*	8.50	23.65	*8.93*	*24.73*
50,000,000	19.22	7.19	20.38	*7.56*	*21.30*	7.76	21.80	*8.16*	*22.80*	8.61	23.93	*9.05*	*25.03*
75,000,000	19.98	7.56	21.30	*7.94*	*22.25*	8.16	22.80	*8.57*	*23.83*	9.05	25.03	*9.50*	*26.15*
100,000,000	20.53	7.83	21.98	*8.22*	*22.95*	8.45	23.53	*8.87*	*24.58*	9.36	25.80	*9.83*	*26.98*

FIGURE E24. THICKNESS DESIGNS FOR 4-INCH CS, CBR 8 AND CBR 9.

CBR = 8 Mr = 3969 %REL = 90	4" CS	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	9.65	2.99	9.88	3.17	10.33	3.09	10.13	3.31	10.40	3.20	10.40	3.54	11.25
250,000	10.70	3.43	10.98	3.64	11.50	3.59	11.38	3.84	12.15	3.90	12.15	4.20	12.90
500,000	11.58	3.79	11.88	4.02	12.45	4.02	12.45	4.28	13.43	4.41	13.43	4.72	14.20
750,000	12.12	4.02	12.45	4.26	13.05	4.28	13.10	4.55	14.20	4.72	14.20	5.04	15.00
1,000,000	12.52	4.19	12.88	4.44	13.50	4.47	13.58	4.75	14.78	4.95	14.78	5.27	15.58
2,500,000	13.86	4.76	14.30	5.03	14.98	5.11	15.18	5.41	16.60	5.68	16.60	6.01	17.43
5,000,000	14.95	5.22	15.45	5.51	16.18	5.62	16.45	5.94	18.03	6.25	18.03	6.60	18.90
7,500,000	15.61	5.51	16.18	5.81	16.93	5.94	17.25	6.26	18.90	6.60	18.90	6.96	19.80
10,000,000	16.10	5.72	16.70	6.03	17.48	6.17	17.83	6.50	19.52	6.85	19.52	7.22	20.45
15,000,000	16.81	6.03	17.48	6.35	18.27	6.50	18.65	6.85	20.45	7.22	20.45	7.60	21.40
20,000,000	17.32	6.25	18.03	6.58	18.85	6.74	19.25	7.10	21.13	7.49	21.13	7.88	22.10
25,000,000	17.72	6.43	18.48	6.77	19.33	6.94	19.75	7.30	21.68	7.71	21.68	8.11	22.68
30,000,000	18.06	6.58	18.85	6.92	19.70	7.10	20.15	7.47	22.10	7.88	22.10	8.29	23.13
35,000,000	18.35	6.71	19.18	7.05	20.03	7.24	20.50	7.61	22.50	8.04	22.50	8.45	23.53
40,000,000	18.60	6.82	19.45	7.17	20.33	7.36	20.80	7.74	22.83	8.17	22.83	8.59	23.88
45,000,000	18.83	6.92	19.70	7.28	20.60	7.47	21.08	7.85	23.13	8.29	23.13	8.71	24.18
50,000,000	19.03	7.01	19.93	7.37	20.83	7.57	21.33	7.95	23.40	8.40	23.40	8.83	24.48
75,000,000	19.82	7.37	20.83	7.75	21.78	7.95	22.28	8.36	24.48	8.83	24.48	9.27	25.58
100,000,000	20.40	7.64	21.50	8.02	22.45	8.24	23.00	8.66	25.25	9.14	25.25	9.59	26.38

CBR = 9 Mr = 4290 %REL = 90	4" CS	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES	DESIGN EALS SN	DESIGN EALS INCHES	1.5(DESIGN EALS) SN	1.5(DESIGN EALS) INCHES
100,000	9.41	2.90	9.65	3.09	10.13	3.00	9.90	3.21	10.43	3.17	10.33	3.42	10.95
250,000	10.44	3.34	10.75	3.54	11.25	3.49	11.13	3.73	11.73	3.77	11.83	4.06	12.55
500,000	11.30	3.70	11.65	3.92	12.20	3.90	12.15	4.16	12.80	4.28	13.10	4.58	13.85
750,000	11.84	3.92	12.20	4.15	12.78	4.16	12.80	4.43	13.48	4.58	13.85	4.90	14.65
1,000,000	12.23	4.08	12.60	4.33	13.23	4.35	13.28	4.62	13.95	4.81	14.43	5.12	15.20
2,500,000	13.56	4.64	14.00	4.91	14.68	4.98	14.85	5.27	15.58	5.53	16.23	5.86	17.05
5,000,000	14.65	5.10	15.15	5.38	15.85	5.49	16.13	5.80	16.90	6.10	17.65	6.44	18.50
7,500,000	15.31	5.38	15.85	5.67	16.58	5.80	16.90	6.12	17.70	6.44	18.50	6.80	19.40
10,000,000	15.80	5.59	16.38	5.89	17.13	6.02	17.45	6.35	18.27	6.69	19.13	7.06	20.05
15,000,000	16.50	5.89	17.13	6.20	17.90	6.35	18.27	6.69	19.13	7.06	20.05	7.43	20.98
20,000,000	17.02	6.11	17.68	6.43	18.48	6.59	18.88	6.94	19.75	7.32	20.70	7.71	21.68
25,000,000	17.42	6.28	18.10	6.61	18.93	6.78	19.35	7.14	20.25	7.53	21.23	7.93	22.23
30,000,000	17.76	6.43	18.48	6.77	19.33	6.94	19.75	7.30	20.65	7.71	21.68	8.11	22.68
35,000,000	18.05	6.56	18.80	6.90	19.65	7.08	20.10	7.45	21.03	7.86	22.05	8.26	23.05
40,000,000	18.30	6.67	19.08	7.01	19.93	7.20	20.40	7.57	21.33	7.99	22.38	8.40	23.40
45,000,000	18.53	6.77	19.33	7.12	20.20	7.30	20.65	7.68	21.60	8.11	22.68	8.52	23.70
50,000,000	18.73	6.86	19.55	7.21	20.43	7.40	20.90	7.78	21.85	8.21	22.93	8.63	23.98
75,000,000	19.53	7.21	20.43	7.58	21.35	7.78	21.85	8.18	22.85	8.63	23.98	9.07	25.08
100,000,000	20.11	7.47	21.08	7.85	22.03	8.06	22.55	8.47	23.58	8.94	24.75	9.39	25.88

FIGURE E25. THICKNESS DESIGNS FOR 4-INCH CS, CBR 10 AND CBR 11.

CBR = 10 Mr = 4598 %REL = 90	4" CS	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*
100,000	9.19	2.83	9.48	3.02	9.95	2.92	9.70	3.12	10.20	3.07	10.08	3.32	10.70
250,000	10.22	3.26	10.55	3.46	11.05	3.40	10.90	3.63	11.48	3.66	11.55	3.95	12.28
500,000	11.08	3.61	11.43	3.83	11.98	3.80	11.90	4.06	12.55	4.16	12.80	4.46	13.55
750,000	11.62	3.83	11.98	4.06	12.55	4.06	12.55	4.32	13.20	4.46	13.55	4.77	14.33
1,000,000	12.01	3.99	12.38	4.23	12.98	4.24	13.00	4.51	13.68	4.68	14.10	5.00	14.90
2,500,000	13.35	4.54	13.75	4.80	14.40	4.86	14.55	5.16	15.30	5.40	15.90	5.73	16.73
5,000,000	14.43	4.99	14.88	5.27	15.58	5.37	15.83	5.67	16.58	5.96	17.30	6.30	18.15
7,500,000	15.10	5.27	15.58	5.56	16.30	5.67	16.58	5.99	17.38	6.30	18.15	6.66	19.05
10,000,000	15.59	5.47	16.08	5.77	16.83	5.89	17.13	6.22	17.95	6.55	18.78	6.91	19.68
15,000,000	16.30	5.77	16.83	6.08	17.60	6.22	17.95	6.55	18.78	6.91	19.68	7.28	20.60
20,000,000	16.82	5.99	17.38	6.30	18.15	6.46	18.55	6.80	19.40	7.17	20.33	7.55	21.28
25,000,000	17.23	6.16	17.80	6.48	18.60	6.64	19.00	6.99	19.88	7.38	20.85	7.77	21.83
30,000,000	17.57	6.30	18.15	6.63	18.98	6.80	19.40	7.16	20.30	7.55	21.28	7.95	22.28
35,000,000	17.86	6.43	18.48	6.76	19.30	6.93	19.73	7.30	20.65	7.70	21.65	8.10	22.65
40,000,000	18.11	6.54	18.75	6.87	19.58	7.05	20.03	7.42	20.95	7.83	21.98	8.24	23.00
45,000,000	18.34	6.63	18.98	6.98	19.85	7.16	20.30	7.53	21.23	7.95	22.28	8.36	23.30
50,000,000	18.54	6.72	19.20	7.07	20.08	7.25	20.53	7.63	21.48	8.05	22.53	8.46	23.55
75,000,000	19.35	7.07	20.08	7.43	20.98	7.63	21.48	8.02	22.45	8.46	23.55	8.89	24.63
100,000,000	19.93	7.32	20.70	7.70	21.65	7.90	22.15	8.30	23.15	8.77	24.33	9.21	25.43

CBR = 11 Mr = 4897 %REL = 90	4" CS	1986 AASHTO DESIGN METHOD											
		Pt = 2.0				Pt = 2.5				Pt = 3.0			
DESIGN EALS	KY DESIGN THICKNESS, IN 1987	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*	DESIGN EALS SN	DESIGN EALS INCHES	*1.5(DESIGN EALS) SN*	*1.5(DESIGN EALS) INCHES*
100,000	8.98	2.77	9.33	2.95	9.78	2.85	9.53	3.05	10.03	2.99	9.88	3.23	10.48
250,000	10.01	3.19	10.38	3.39	10.88	3.32	10.70	3.55	11.28	3.56	11.30	3.84	12.00
500,000	10.86	3.53	11.23	3.75	11.78	3.72	11.70	3.96	12.30	4.05	12.53	4.35	13.28
750,000	11.40	3.75	11.78	3.98	12.35	3.96	12.30	4.22	12.95	4.35	13.28	4.66	14.05
1,000,000	11.79	3.91	12.18	4.14	12.75	4.15	12.78	4.41	13.43	4.57	13.83	4.88	14.60
2,500,000	13.11	4.45	13.53	4.71	14.18	4.76	14.30	5.05	15.03	5.28	15.60	5.61	16.43
5,000,000	14.19	4.89	14.63	5.17	15.33	5.26	15.55	5.56	16.30	5.84	17.00	6.18	17.85
7,500,000	14.85	5.17	15.33	5.45	16.03	5.56	16.30	5.87	17.08	6.18	17.85	6.53	18.73
10,000,000	15.33	5.37	15.83	5.66	16.55	5.78	16.85	6.10	17.65	6.43	18.48	6.78	19.35
15,000,000	16.03	5.66	16.55	5.96	17.30	6.10	17.65	6.43	18.48	6.78	19.35	7.15	20.28
20,000,000	16.54	5.87	17.08	6.19	17.88	6.33	18.23	6.67	19.08	7.04	20.00	7.42	20.95
25,000,000	16.95	6.04	17.50	6.36	18.30	6.52	18.70	6.87	19.58	7.25	20.53	7.63	21.48
30,000,000	17.28	6.19	17.88	6.51	18.68	6.67	19.08	7.03	19.98	7.42	20.95	7.80	21.90
35,000,000	17.57	6.31	18.18	6.64	19.00	6.81	19.43	7.17	20.33	7.56	21.30	7.96	22.30
40,000,000	17.82	6.42	18.45	6.75	19.28	6.92	19.70	7.29	20.63	7.69	21.63	8.09	22.63
45,000,000	18.04	6.51	18.68	6.85	19.52	7.03	19.98	7.39	20.88	7.80	21.90	8.21	22.93
50,000,000	18.25	6.60	18.90	6.94	19.75	7.12	20.20	7.49	21.13	7.91	22.18	8.31	23.18
75,000,000	19.04	6.94	19.75	7.30	20.65	7.49	21.13	7.88	22.10	8.31	23.18	8.74	24.25
100,000,000	19.61	7.19	20.38	7.56	21.30	7.76	21.80	8.16	22.80	8.61	23.93	9.05	25.03