COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

HENRY WARD
COMMISSIONER OF HIGHWAYS

May 23, 1962

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
MATERIALS RESEARCH LABORATORY
132 GRAHAM AVENUE
LEXINGTON 29, KENTUCKY

P.3.1.1.
D.1.7.

MEMO TO: R. O. Beauchamp
Assistant State Highway Engineer

We have reviewed the AASHO Interim Guide for the Design of Rigid Pavement Structures, and Messrs. Havens and Hughes of our staff have prepared comments on the guide. These comments do not deal entirely with the rigid pavement guide, but rather compare some of the design concepts from the Flexible Pavement Interim Guide.

We have been particularly interested in AASHO traffic factors and the development of composite traffic data from the single traffic level available on the AASHO Road Test. It appears that the equivalent 18,000 lb. axle load and the 10,000 lb. axle load used in Kentucky correlate very well.

Our comments cover primarily a comparison of Kentucky flexible and rigid pavement design criteria with the AASHO Interim Guides. Table 2 of the attached comments lists the rigid pavement thicknesses obtained from AASHO curves for various stated conditions using Kentucky traffic values converted to equivalent daily AASHO 18-kip axles.

It is apparent that by using the flexural strength of 600 psi and AASHO recommended design level of 0.75 S_c that the following thicknesses of slabs would be required.

Kentucky Traffic Curve No.	PCC Slab Thickness (in.)
VIII	8
IX	9
X	10

These values are consistent with present structural design practices for primary and interstate rigid pavements.

During the recent Highway Research Board meeting in St. Louis, Mo., Mr. W. J. Liddle discussed the AASHO Interim Guides for flexible and rigid pavements. I had an opportunity to talk with Mr. Liddle and he advised me that the rigid pavement guide was being revised and was expected to be distributed to members of AASHO Operating Committee on Design in June. I discussed very briefly some of our questions.

Sufficient extra copies of our comments have been prepared for whatever distribution that you wish to make. We have not seen fit to make strenuous objections to the interim guide or the concepts presented. We have noted on pages 7 through 11 some factors that we believe deserve discussion or consideration. These factors are of primary importance in Kentucky design practices and our relationships to the AASHO policy guides, but may have limited significance to the AASHO Operating Design Committee.

Respectfully submitted,

W B Drake

W. B. Drake
Director of Research

WBD:dl
Enc.
cc: A. O. Neiser

Comments on:

AASHO INTERIM GUIDE FOR THE DESIGN OF RIGID PAVEMENT STRUCTURES (AASHO Committee on Design, February, 1962)

by

J. H. Havens
Assistant Director of Research
and
R. D. Hughes
Research Engineer Associate

May 1, 1962

The equivalency factors given for the various axle loads for the design of rigid pavements differ slightly from those given in the "AASHO Recommended Guide for the Design of Flexible Pavement Structures (July 25, 1961)." Consequently, the summation of EWL's or average daily 18-kip (equivalent) axles computed from a particular set of traffic data (for a particular road) will differ somewhat according to the type of pavement being designed. Therefore, in order to be able to design equivalent flexible and rigid pavements (equal alternates), two separate traffic computations are needed. For instance:

Rigid Pavements

$$\text{18-kip axles per day} = \frac{\sum n_1 f_1 + n_2 f_2 + n_3 f_3 \ldots}{7300}$$

where:

n = no. of axles of a given load in 20 yrs.,
f = respective load-equivalency factors, rigid pavements,
7300 = 20 yrs. x 365 days.

Flexible Pavements

$$\text{18-kip axles per day} = \frac{\sum n_1 f_1' + n_2 f_2' + n_3 f_3 \ldots}{7300}$$

where

n = no. of axles of a given load in 20 yrs.,

f' = respective load-equivalency factors, flexible pavement,

7300 = 20 yrs. x 365 days.

While it is thus possible to compute AASHO equivalent, daily 18-kip axles from raw traffic data (loadometer data and projected traffic counts), it is desirable to be able to convert Ky. EWL's (5,000-lb. wheel, 5-ton axles, or 10-kip axle basis) to the 18-kip axle basis. This appears to be possible inasmuch as the Ky. EWL's are computed in much the same manner as described above. For instance:

Ky. EWL's (10 kip axles, 2 directions, 20 yrs.) $= \sum n_1 f_1'' + n_2 f_2'' + n_3 f_3'' \ldots$

$$\sum n_1 f_1'' + n_2 f_2'' + n_3 f_3'' \ldots = n \bar{f}'' \text{ or } \bar{n} f''$$

Thus, Ky. EWL's (10-kip axle) may be converted to an 18-kip axle basis ($f'' = 16$) as follows:

$$\frac{\text{Ky. EWL's (10-kip)}}{\text{Ky. EWL's (18-kip)}} = \frac{n_{10} f_{10}''}{n_{18} f_{18}''} = \frac{n_{18} \times 1}{n_{18} \times 16}$$

If Ky. EWL's (10 kip) = Ky. EWL's (18 kip), then n_{10} must be 16 times greater than n_{18}; in other words, it takes 16 times as many repetitions of a 10-kip axle to produce the same EWL that n applications of an 18-kip axle would produce. Hence, the conversion of Ky. EWL's (10-kip basis) to Ky. EWL's (18-kip basis) is accomplished by dividing the 10-kip EWL by 16. The 10-kip, 20-yr., 2-direction, EWL converted to the 18-kip basis may be further reduced to equivalent daily applications in one direction by dividing by 2 x 7300. Moreover, if it is desired to convert from the 10-kip, 20-yr., 1-direction, Ky. EWL, this may be accomplished by dividing 32. Similarly, present Ky. EWL's divided by 32 gives 20-yr. EWL's on approximately the same basis as AASHO EWL's computed over 20 yrs. - that is:

Ky. EWL's/32 = AASHO EWL's (20 yr.)

The above conversion is only approximate inasmuch as the AASHO load-equivalency factors, as mentioned before, differ somewhat with respect to the stated conditions, i.e. $P_t = 2.0$ or 2.5, $\overline{SN}$ (flexible), and D_2 (rigid).

In an effort to derive more precise conversions, the logarithm of AASHO equivalency factors (f_A) given for each of the stated conditions were plotted versus the logarithm of the respective axle loads

(P_A, in kips), and in each case a nearly straight-line relationship was found. The linear equations thus obtained (from both rigid and flexible pavement reports) are given below for the several stated conditions:

AASHO Flexible Pavements

Single Axle, $P_t = 2.0$: $\log P_A = .23245 \log f_A + \log 18.154$

$$P_A = 18.154\, f_A^{.23245}$$

Single Axle, $P_t = 2.5$: $\log P_A = .24544 \log f_A + \log 18.028$

$$P_A = 18.028\, f_A^{.24544}$$

Tandem Axle, $P_t = 2.0$: $\log P_A = .22038 \log f_A + \log 32.719$

$$P_A = 32.719\, f_A^{.22038}$$

Tandem Axle, $P_t = 2.5$: $\log P_A = .24500 \log f_A + \log 32.750$

$$P_A = 32.750\, f_A^{.24500}$$

AASHO Rigid Pavements

Single Axle, $P_t = 2.0$: $\log P_A = .23492 \log f_A + \log 18.054$

$$P_A = 18.054\, f_A^{.23492}$$

Single Axle, $P_t = 2.5$: $\log P_A = .23938 \log f_A + \log 18.009$

$$P_A = 18.009\, f_A^{.23938}$$

Tandem Axle, $P_t = 2.0$: $\log P_A = .233875 \log f_A + \log 28.855$

$$P_A = 28.855\, f_A^{.233875}$$

Tandem Axle, $P_t = 2.5$: $\log P_A = .249599 \log f_A + \log 29.175$

$$P_A = 29.175\, f_A^{.249599}$$

In the present Ky. system of computing EWL's, the relationship between P_k (Ky. basic axle load in tons) and f_k (Ky. equivalency factor) is given by:

$$f_k = (2)^{P_k - 5}$$

The ratio between Ky. EWL's and AASHO EWL's is given by:

$$\frac{\text{Ky. EWL's}}{\text{AASHO EWL's}} = \frac{2\ f_k}{f_A}$$

$$2\ f_k = 2(2)^{P_k - 5} = (2)^{P_k - 4}$$

$$\frac{\text{Ky. EWL's}}{\text{AASHO EWL's}} = \frac{(2)^{P_k - 4}}{f_A}$$

On the basis described above, the following ratios or converting factors have been derived:

Flexible Pavements

Single Axle, $P_t = 2.0$: Ky. EWL's/34.7939 = AASHO EWL's

Single Axle, $P_t = 2.5$: Ky. EWL's/32.2711 = AASHO EWL's

Tandem Axle, $P_t = 2.0$: Ky. EWL's/ 426.667 = AASHO EWL's

Tandem Axle, $P_t = 2.5$: Ky. EWL's/369.231 = AASHO EWL's

Rigid Pavements

Single Axle, $P_t = 2.0$: Ky. EWL's/32.9557 = AASHO EWL's

Single Axle, $P_t = 2.5$: Ky. EWL's/32.1479 = AASHO EWL's

Tandem Axle, $P_t = 2.0$: Ky. EWL's/237.037 = AASHO EWL's

Tandem Axle, $P_t = 2.5$: Ky. EWL's/231.325 = AASHO EWL's

Using the above conversion factors for single axles only, the eleven Ky. traffic groups, Curves IA thru X, resolve as follows:

Table 1. Summary of Conversions of Ky. EWL's to AASHO Traffic Basis

Ky. Traf. Curve	Ky. EWL 20-Yr. (10^6)	Ky. Daily Equiv. 10-kip Axles	20-Yr. AASHO EWL (10^6)				Equiv. Daily AASHO 18-kip Axles			
			Flexible		Rigid		Flexible		Rigid	
			P_t		P_t		P_t		P_t	
			2.0	2.5	2.0	2.5	2.0	2.5	2.0	2.5
IA	0.25	17	0.0072	0.0078	0.0076	0.0078	1	1	1	1
I	0.50	35	0.0144	0.0155	0.0152	0.0156	2	2	2	2
II	1	69	0.0287	0.0310	0.0303	0.0311	4	4	4	4
III	2	137	0.0575	0.0620	0.0607	0.0622	8	9	9	9
IV	4	274	0.1150	0.1240	0.1214	0.1244	16	17	17	17
V	8	548	0.2299	0.2479	0.2428	0.2489	32	34	34	34
VI	16	1,096	0.4599	0.4958	0.4855	0.4977	63	68	67	68
VII	32	2,192	0.9197	0.9916	0.9710	0.9954	126	136	133	137
VIII	64	4,384	1.8394	1.9832	1.9420	1.9908	252	272	266	273
IX	128	8,767	3.6788	3.9664	3.8840	3.9816	504	544	532	546
X	256	17,534	7.3576	7.9328	7.7680	7.9632	1008	1087	1064	1091

The above table, thus, provides the necessary conversions of Ky. EWL's to AASHO traffic values; and it follows that the AASHO traffic values so obtained provide a basis whereby thicknesses of flexible pavements (KY. Design Chart) may be compared with thicknesses ($\overline{SN}$ values) obtained by solution of the AASHO equations for the design of flexible pavements or as obtained by the use of the nomographs provided. It follows, likewise, that comparable or equivalent designs for rigid pavements may be obtained by using the appropriate traffic conversion and the equation or nomograph applicable to rigid pavements. However, this is presumably so now only insofar as the analysis of traffic is concerned. Although, the possibility of making actual comparisons of thicknesses in this way is foreseen, there are certain factors yet to be resolved. Those involving flexible pavements are:

1. The establishment of a satisfactory relationship between the Ky. CBR value and the soil support value (S) as used in the AASHO report on flexible pavements. Preliminary comparisons between structural index numbers ($\overline{SN}$) computed from typical flexible pavements being designed by the Ky. system and those obtained from the AASHO nomograph suggests that a Ky. CBR-5 corresponds to a soil support value within the range of 2.5 to 3.0.

Note: A laboratory study which, it is hoped, will resolve a reliable relationship is in progress.

2. The establishment of a reliable regional factor (R) for use in the AASHO flexible pavement design system. Preliminary analyses indicate that an R-value of 1.00 or close thereto would be appropriate; however, this lacks confirmation.

3. The structural coefficients given by AASHO for bituminous concrete is 0.44 per inch of thickness; whereas, that given for crushed stone base is 0.14 per inch of thickness.

$\overline{SN}$ = 0.44 x Thickness of Surface + 0.14 x thickness of base.

Total thickness - thickness of base = thickness of surface.

$$\overline{SN} = 0.44\ T_t - 0.44\ T_b + 0.14\ T_b$$

While it is possible to interpolate total thickness from the Ky. design curves (for a given traffic group and CBR), it is apparent that the thicknesses of pavement components may be appropriated or selected in such a way as to yield almost any desired value of $\overline{SN}$. However, since Ky. flexible pavements are by and large two component systems, any desired $\overline{SN}$ and total thickness may be equated as above to find the needed thicknesses of the respective component layers.

The structural coefficients recommended by AASHO may be subject to some modification inasmuch as they apply specifically to the type and quality of materials used in the Test Road. On an inch-per-inch basis, these coefficients credit bituminous concrete with slightly more than three times as much structural integrity as crushed rock base; whereas, heretofore, most design engineers have considered this ratio to be in the order of 1.5 to 1.8. It is likely, therefore, that more conservative coefficients (and ratios) may be adopted in order to reconcile the AASHO design criterion with long-standing design practices elsewhere. For instance, a slight moderation of the 0.44

coefficient (bituminous concrete) to 0.40 and an increase in the 0.14 coefficient to perhaps 0.20 for Ky. DGA base (thought to represent the highest quality of uncemented base) would be worthy of consideration.

Factors involving rigid pavements and which are yet to be resolved are:

1. The AASHO report on rigid pavements states that the flexural strength (modulus of rupture) of the concrete in the test road was 690 psi. Heretofore, it has been the practice to limit the maximum design stress to 50% of ultimate (safety factor of 2). The present report suggests that 75% of ultimate (.75 S_c) would be satisfactory. This factor bears significantly upon the thickness of the pavement; and, whereas .75 S_c (.75 x 690 psi) may have been a satisfactory stress-level in the performance of the Test Road -- attributable perhaps to greater uniformity in the preparation and in the supporting value of the foundation -- it is doubtful that a similar degree of perfection in this respect is economically achievable in routine construction.

Note: Ky. Specs., Article 4.1.5-D, page 140, requires 600 psi flexural strength for paving concrete at 28 days. Doubtlessly, strength increases somewhat beyond 28 days. However, inasmuch as this is the only flexural strength ever required, it may be argued that this value (600 psi) should be used for design purpose. As a matter of interest, both 0.50 S_c and 0.75 S_c (S_c = 600) are included in some of the analyses that follow.

2. Although the AASHO guide for the design of rigid pavements proposes that traffic (equiv., daily, 18-kip axles) be computed for a 20-yr. period, in the same manner that Ky. EWL's are computed and as recommended in the guide for the design of flexible pavements, it states that the traffic-period should "...not be confused with pavement life, which is affected by many factors in addition to traffic loading." While it is understandable that many

factors other than traffic affect pavement life, there seems to be a serious conflict with logic in the attitude that the traffic period is something other than the designed-life of the pavement. In other words, the traffic period should logically represent the best estimate of the life-span of the pavement-- that is, including all factors however undefinable they may be and/or experience. The prediction of traffic 20 years hence is often grossly underestimated and perhaps less frequently overestimated, but the estimates are surely based upon logic and the best information available at the time they are made. From this point of view, it would seem that pavement-life estimates may be about as accurate as traffic estimates. Doubtlessly, considerable effort was made in design of the Test Road and in the analysis of the data to preserve logic and theory, and it seems improper in the Design Committee's guide to dismiss a basic concept in such an unqualified way. If the design criterion given in the guide is reliable and valid, the design-life of the pavement is determined wholly by the period over which the traffic is estimated.

3. In regard to the "Subbase Recommendations" (Appendix B of the guide), it appears that the subbase thicknesses (thickness of insulation course in Ky.) recommended there are not well substantiated and that the particular subbase materials are not well defined. Kentucky's DGA insulation appears to conform most closely to the Type B classification, and most Kentucky soils would fall into a CBR range corresponding to a modulus of subgrade reaction (k) of 125 to 300. According to the guide recommendations, this would require at least 9 inches of DGA insulation whereas present practices on Interstate construction call for 6 inches, and lighter construction calls for 3 to 5 inches. Of course, it is well recognized that the combined thickness of pavement and insulation is important from the standpoint of depth of freezing etc. and that the insulation must be designed so as to prevent pumping and intrusions of subgrade soil.

Foreseeably, some controversies may evolve from these unqualified recommendations -- that is, depending upon local conditions throughout the country. As a case in point, Childs, et al, (Portland Cement Association), Proceedings, ASCE, Paper 1297, July, 1957), presents an entirely opposite picture. In part, he says: "The stresses induced at the edge of and at a free corner in a 6-in. slab on a 6-in. well compacted, dense-graded subbase were the same as would be expected in a 6-1/2-in. slab with no subbase; and the stresses in a 6-in. slab on a 12-in. subbase were the same as would be expected in a 7-in. slab with no subbase.

"The deflections at the edge of a 6-in. slab on a 6-in. subbase were the same as would be expected with a 7-1/2-in. slab with no subbase; and the deflection of a 6-in. slab on a 12-in. subbase were the same as would be expected in an 8-in. slab with no subbase.

"...Thus, on low bearing value subgrades, it appears that strains may be reduced effectively and economically by small increases in slab thickness and that deflections may be reduced substantially by the use of a dense-graded, well compacted subbase. The greatest effectiveness per inch of subbase in the reduction of deflections is obtained with subbases about 6 in. thick. Since experience indicates that subbases of this thickness, or even less, will prevent pumping, the use of subbases of greater thickness may not be structurally economical."

Childs, et. al., also presents a similar viewpoint in a subsequent paper (Proceedings, ASCE, Paper 1800, Oct. 1958.)

It is of interest now to compare the results obtainable from the guide for the design of rigid pavements in terms of Kentucky traffic converted to AASHO Traffic. A number of such comparisons are provided in Table 2, which is otherwise self-explanatory. Similarly, it is of interest to compare the results obtainable from the guide for the design of flexible pavements (equal Ky. traffic) and from the standpoint of typical Kentucky pavements. A number of such comparisons are provided in Table 3. The main comparison there is provided by the structural index ($\overline{SN}$) as obtained from the guide for the stated conditions and the $\overline{SN}$ values computed from the typical Kentucky designs using the AASHO structural coefficient of 0.44 for bituminous concrete surface and 0.14 and DGA base.

Attachments:

1. Ky. Design Chart
2. Copy of EWL computations, East Ky. Toll Road
3. East Ky. Toll Road traffic converted to AASHO basis using raw traffic data and AASHO equivalency factors, $P_t = 2.0$.
4. (Same as 3 above, using $P_t = 2.5$)
5. AASHO Design Chart, Flexible Pavements (400-1, revised)
6. AASHO Design Chart, Flexible Pavements (400-2, revised)
7. AASHO Design Chart, Rigid Pavements (400-1)
8. AASHO Design Chart, Rigid Pavements (400-2)

Table 2. Rigid Pavement Thicknesses Obtained by AASHO Design Guide for Various Stated Conditions and Daily Equivalent 18-kip, Single Axles Converted from Ky. EWL-Groups.

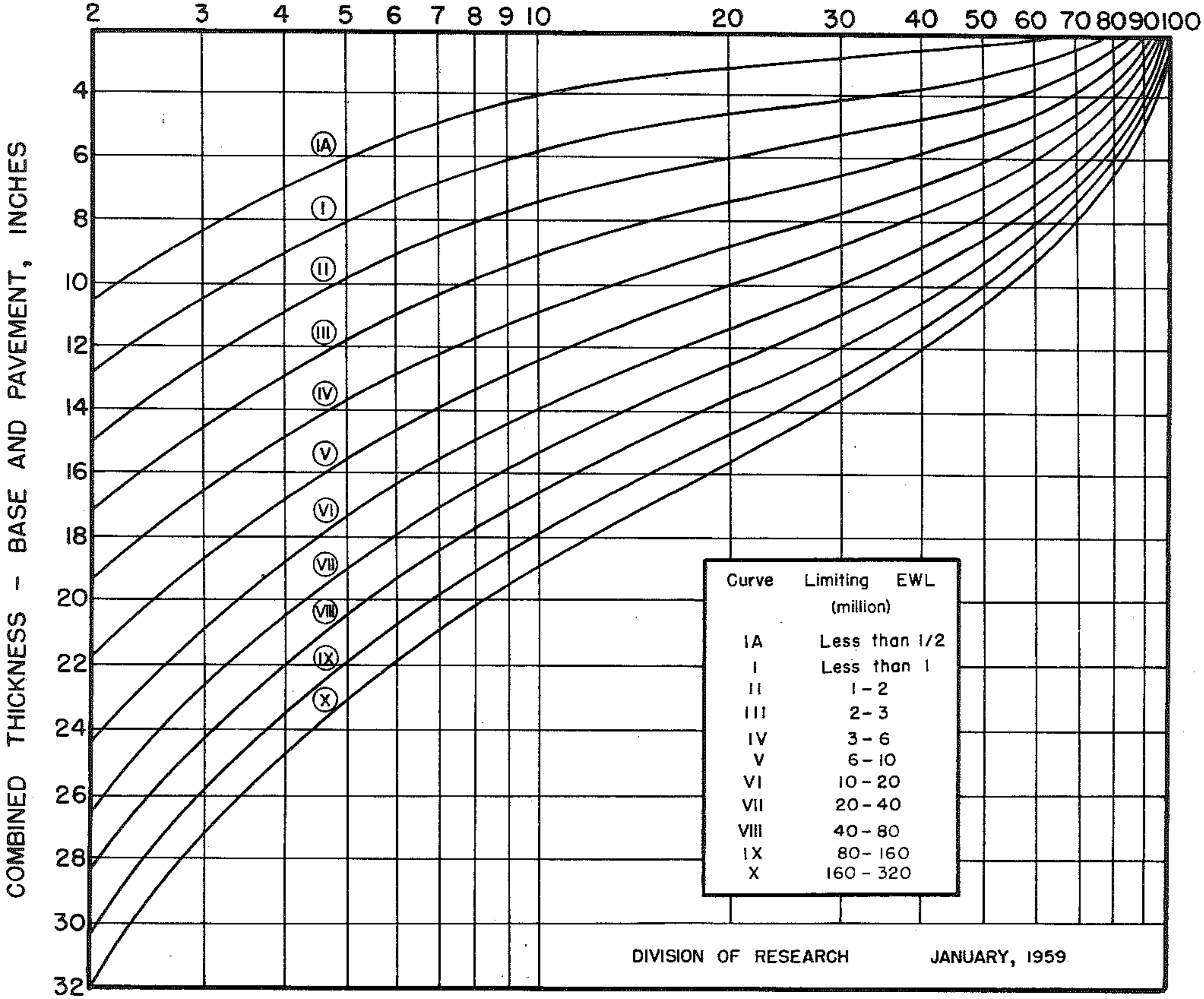
Ky. Traffic Curve	$P_t = 2.0$ K = 150 (CBR - 5)					$P_t = 2.5$ K = 150 (CBR - 5)				
	Equiv. Daily AASHO 18-kip Axles	Thickness - In.				Equiv. Daily AASHO 18-kip Axles	Thickness - In.			
		$S_c = 690$		$S_c = 600$			$S_c = 690$		$S_c = 600$	
		$.5\ S_c$	$.75\ S_c$	$.5\ S_c$	$.75\ S_c$		$.5\ S_c$	$.75\ S_c$	$.5\ S_c$	$.75\ S_c$
IA	1	<6	<6	<6	<6	1	<6	<6	<6	<6
I	2	<6	<6	<6	<6	2	<6	<6	<6	<6
II	4	<6	<6	<6	<6	4	<6	<6	<6	<6
III	9	<6	<6	<6	<6	9	<6	<6	<6	<6
IV	17	<6	<6	6.39	<6	17	<6	<6	6.50	<6
V	34	6.51	<6	7.24	<6	34	6.55	<6	7.43	<6
VI	67	7.24	<6	8.16	6.02	68	7.48	<6	8.30	6.12
VII	133	8.08	6.20	8.96	6.81	137	8.30	6.32	9.22	6.98
VIII	266	8.92	6.94	9.88	7.60	273	9.45	7.35	10.48	7.95
IX	532	10.16	8.03	11.20	8.72	546	10.55	8.28	11.43	8.91
X	1064	11.21	8.96	12.37	9.73	1091	11.63	9.20	12.62	9.90

Note: Guide states: "Where the design analysis indicates a slab thickness of less than 8 inches, careful consideration must be given to environmental conditions, and to the construction problems to be encountered, before the lesser thickness is used."

Table 3. Structural Indexes ($\overline{SN}$) Obtained from AASHO Design Guide for Flexible Pavements for Various Stated Conditions and Daily Equivalent 18-kip Single Axles Converted from Ky. EWL-Groups. Typical Ky. Pavements and their Corresponding AASHO Values of $\overline{SN}$ are Shown for Comparison.

Ky. Design Curve	$\overline{SN}$ (Charts 400-1 and 400-2)*						Total Thickness (Ky. Chart) (in.)***	Bituminous Concrete (in.)	DGA (in.)	Computed $\overline{SN}$
	S = 3.0**, P_t =		S = 2.8, P_t =		S = 2.5, P_t =					
	2.0	2.5	2.0	2.5	2.0	2.5				
IA	(1.75)	(1.71)	(1.83)	(1.79)	(1.93)	(1.91)				
I	(1.97)	(1.99)	(2.05)	(2.07)	(2.15)	(2.19)				
II	2.19	2.27	2.27	2.32	2.36	2.44	10	3.5	6.5	2.45
III	2.41	2.55	2.50	2.63	2.60	2.75	12			
IV	2.73	2.81	2.81	2.89	2.93	3.02	14	3.5	10.5	3.00
V	3.01	3.21	3.11	3.28	3.22	3.41	15.5			
VI	3.35	3.55	3.45	3.63	3.56	3.80	17.5	4.0	13.5	3.65
VII	3.72	3.95	3.82	4.04	3.93	4.20	19	4.5	14.5	4.01
VIII	4.13	4.39	4.26	4.51	4.40	4.66	20.5			
IX	4.59	4.89	4.69	5.01	4.83	5.20	22	6.5	15.5	5.00
X	5.01	5.50	5.13	5.62	6.27	5.78	23	7.5	15.5	5.47

* Regional Factor (R) = 1.00
** Soil Support Value (S) for AASHO Test Road = 3.0
*** Ky. CBR = 5, Assumed.
( ) Extrapolated Values.



FLEXIBLE PAVEMENT DESIGN CURVES

Fig. 20: Revised Flexible Pavement Design Curves.

TRAFFIC VOLUME GROUP 3000 ∔

COUNTY ______ ROAD NAME **Eastern Kentucky Toll Road** ROUTE NO. ______

PROJECT LIMITS **Campton to Salyersville*** PROJECT NO. ______

LOADOMETER STATION REFERENCE ______

(1) Per Cent of Trucks . **(1980)** **20**

(2) Average Axles per Truck **3.11**

(3) Average 24 Hour Traffic **** 3000 (1980) For 20 yr. period (1965-85)** **2416**

(4) Average 24 Hour Truck Traffic = (1) x (3) . . . . ______

(5) Average 24 Hour Truck Traffic at End of 20 Year Period **483**

(6) Average Axles per Truck at End of 20 Year Period = (2) ∔ 0.19 . . **3.30**

(7) Total Axles in 20 Years = (5) x (6) x 365 x 20 . . . . **11,635,470**

(A) Axle Load (Tons)	(B) Total Axles (7)	(C) % of Total Axles From Load Sta.	(D) Correction	(E) Corrected % of Total Axles (C) ∔ (D)	(F) Total Axles by Weight Class (B) x (E)	(G) EWL Factor	(H) EWL for Two Directions (F) x (G)
4½-5½		7.097	0.09	7.187	836,241	1	836,241
5½-6½		6.963	0.13	7.093	825,304	2	1,650,608
6½-7½		9.136	0.27	9.406	1,094,432	4	4,377,728
7½-8½	11,635,470	8.384	0.15	8.534	992,971	8	7,943,768
8½-9½		5.500	0.11	5.610	652,750	16	10,444,000
9½-10½		1.112	0.05	1.162	135,204	32	4,326,528
10½-11½		0.031	0	0.031	3,607	64	230,848
11½-12½		0.092	0	0.092	10,705	128	1,370,240

TOTAL EWL for 20 year period (two directions) **31,179,961**

*Assuming road to be toll free and partially controlled

**Traffic estimate obtained from letter of Wilbur Smith & Associates, dated August 31, 1961, and projected according to Table IV-4, of report dated November, 1961, by Wilbur Smith & Associates. "Proposed Eastern Kentucky Toll Road Extension".

TRAFFIC VOLUME GROUP 3000+

COUNTY__________ ROAD NAME Eastern Ky. Toll Road ROUTE NO.________

PROJECT LIMITS Campton-Salyersville PROJECT NO.________

LOADOMETER STATION REFERENCE__________

(1) Per Cent of Trucks . . (1980) 20.00

(2) Average Axles per Truck 3.11

(3) Average 24 Hour Traffic 3000 (1980) for 20 yr. (1965-1985) 2416

(4) Average 24 Hour Truck Traffic = (1) x (3) . . . . ________

(5) Average 24 Hour Truck Traffic at End of 10 Year Period = 1.465 x (4) . 483

(6) Average Axles per Truck at End of 10 Year Period = (2) + 0.19 . . . . 3.30

(7) Total Axles in 20 Years = (5) x (6) x 365 x 20 11,635,470

(A) Axle Load (Tons)	(B) Total Axles (7)	(C) % of Total Axles From Load Sta.	(D) Correction	(E) Corrected % of Total Axles (C) + (D)	(F) Total Axles by Weight Class (B) x (E)	(G) EWL Factor AASHO	(H) EWL for Two Directions
4½-5½	Same as Item	7.097	0.09	7.187	836,241	.08	66,899
5½-6½		6.963	0.13	7.093	825,304	.18	148,555
6½-7½		9.136	0.27	9.406	1,094,432	.35	383,051
7½-8½		8.384	0.15	8.534	992,971	.61	605,712
8½-9½		5.500	0.11	5.610	652,750	1.00	652,750
9½-10½		1.112	0.05	1.162	135,204	1.56	210,918
10½-11½		0.031	0.00	0.031	3,607	2.32	8,368
11½-12½		0.092	0.00	0.092	10,705	3.34	35,755
TOTAL EWL for 20 year period (two directions)							2,112,008

P_T = 2.00 1 Direction 1,056,004

Equivalent, Daily, 18-kip Axles = $\frac{1,056,004}{7300}$ = 145

Slab Thickness (from Nomograph) = 6.87 inches

TRAFFIC VOLUME GROUP 3000+

COUNTY ____________ ROAD NAME Eastern Ky. Toll Road ROUTE NO. ______

PROJECT LIMITS Campton-Salyersville PROJECT NO. ______

LOADOMETER STATION REFERENCE ______

(1) Per Cent of Trucks . . . (1980) 20.00

(2) Average Axles per Truck 3.11

(3) Average 24 Hour Traffic 3000 (1980) for 20 yr. (1965-1985) . . . 2416

(4) Average 24 Hour Truck Traffic = (1) x (3) 483

(5) Average 24 Hour Truck Traffic at End of 10 Year Period = 1.465 x (4) .

(6) Average Axles per Truck at End of 10 Year Period = (2) + 0.19 . . . . 3.30

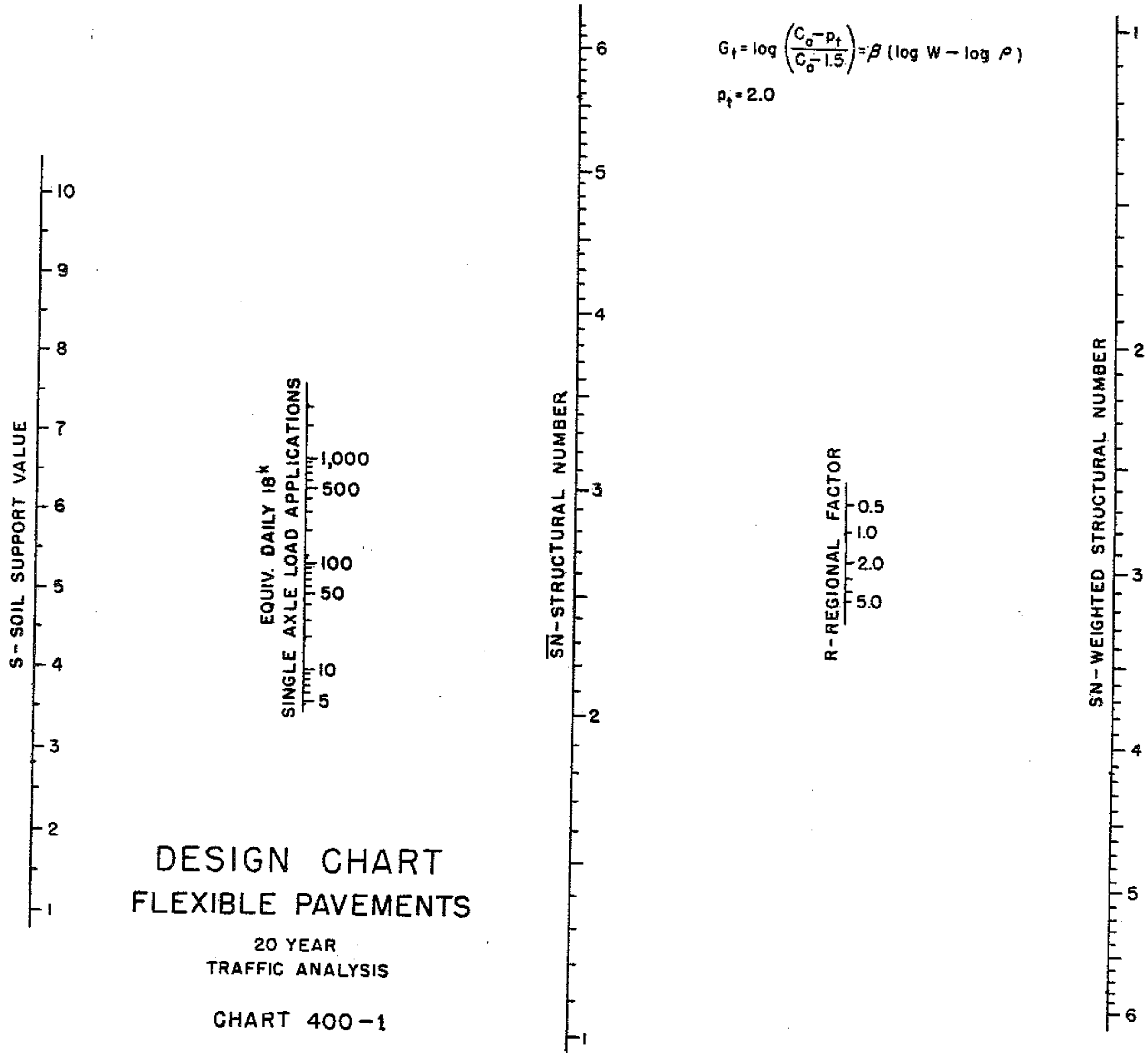
(7) Total Axles in 20 Years = (5) x (6) x 365 x 20 11,035,470

(A) Axle Load (Tons)	(B) Total Axles (7)	(C) % of Total Axles From Load Sta.	(D) Correction	(E) Corrected % of Total Axles (C) + (D)	(F) Total Axles by Weight Class (B) x (E)	(G) EWL Factor AASHO	(H) EWL for Two Directions
4½-5½	Same as No. 7	7.097	0.09	7.187	836,241	.09	75,262
5½-6½		6.963	0.13	7.093	825,304	.19	156,808
6½-7½		9.136	0.27	9.406	1,094,432	.36	393,995
7½-8½		8.384	0.15	8.534	992,971	.62	616,642
8½-9½		5.500	0.11	5.610	652,750	1.00	652,750
9½-10½		1.112	0.05	1.162	135,204	1.52	205,510
10½-11½		0.031	0.00	0.031	3,607	2.20	7,935
11½-12½		0.092	0.00	0.092	10,705	3.10	33,186
TOTAL EWL for 20 year period (two directions)							2,141,088

P_T = 2.5   1 Direction 1,070,544

Equivalent, Daily, 18-kip Axles = $\frac{1,070,544}{7300}$ = 147

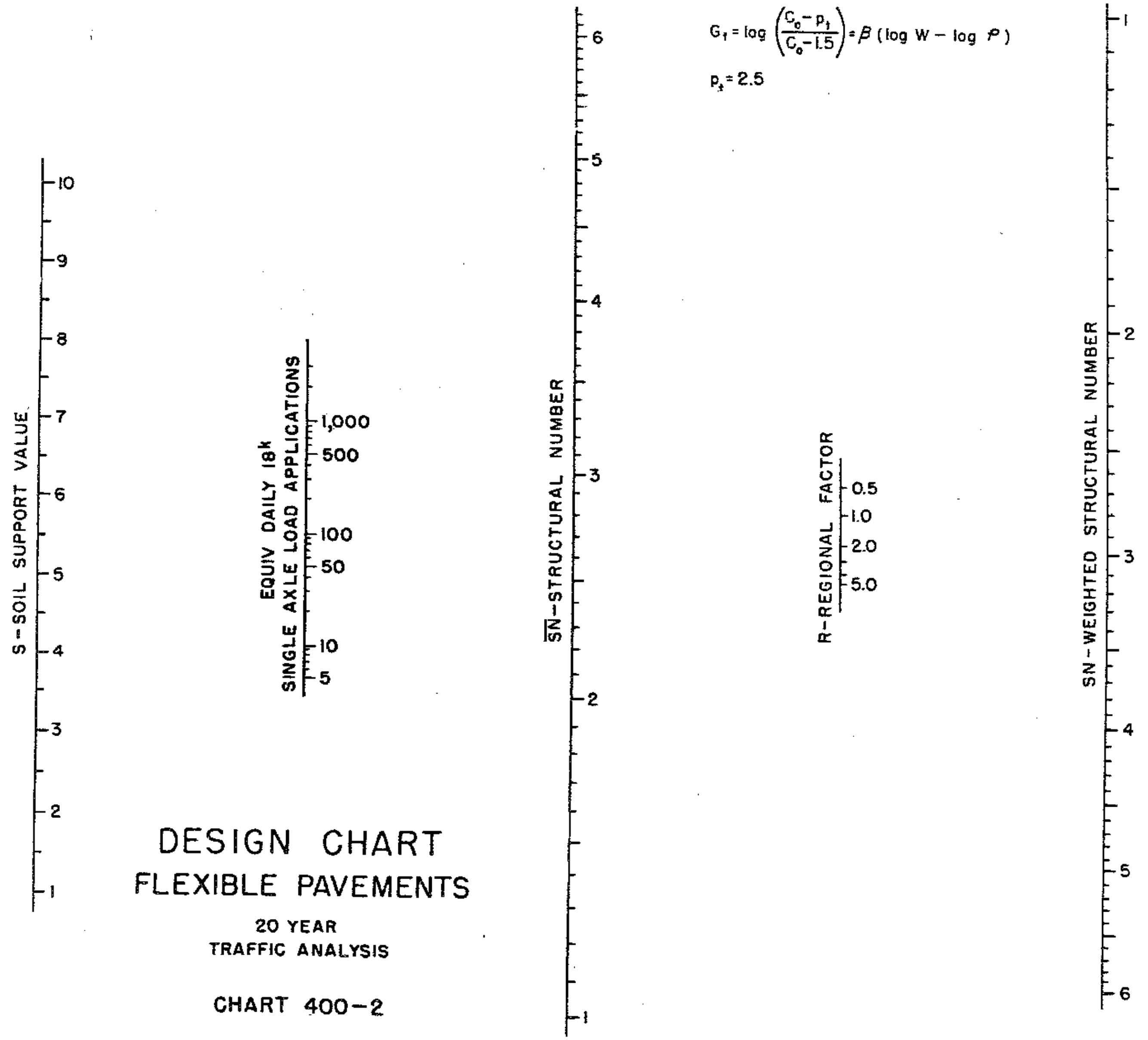
Slab Thickness (from Nomograph) = 7.19 inches



DESIGN CHART
FLEXIBLE PAVEMENTS

20 YEAR
TRAFFIC ANALYSIS

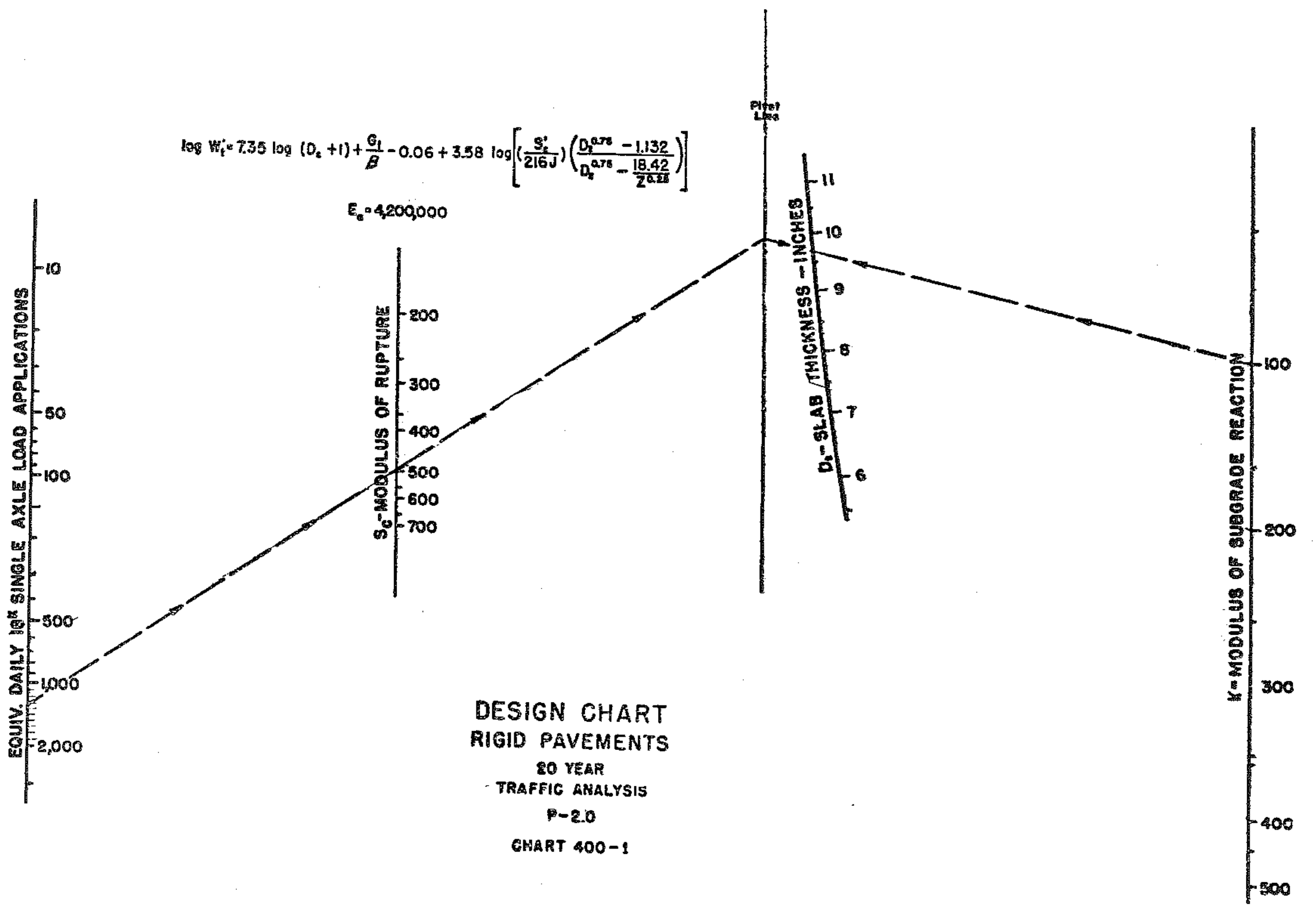
CHART 400-1



DESIGN CHART
FLEXIBLE PAVEMENTS

20 YEAR
TRAFFIC ANALYSIS

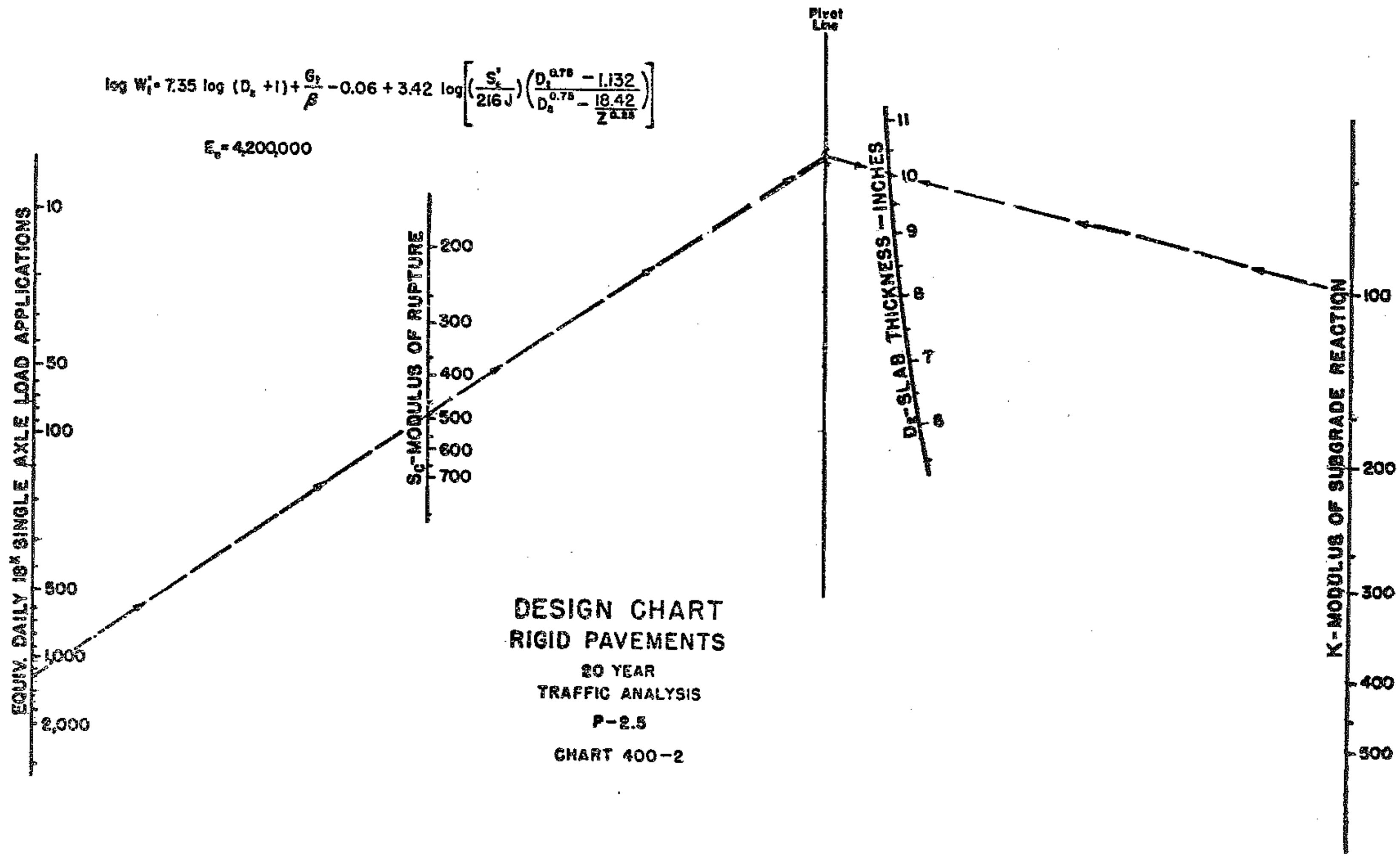
CHART 400-2



DESIGN CHART
RIGID PAVEMENTS
20 YEAR
TRAFFIC ANALYSIS
P-2.0
CHART 400-1

$$\log W_t' = 7.35 \log (D_2 + 1) + \frac{G_t}{\beta} - 0.06 + 3.42 \log\left[\left(\frac{S_c'}{216 J}\right)\left(\frac{D_2^{0.75} - 1.132}{D_2^{0.75} - \frac{18.42}{Z^{0.25}}}\right)\right]$$

$E_c = 4{,}200{,}000$



DESIGN CHART
RIGID PAVEMENTS

20 YEAR
TRAFFIC ANALYSIS

P-2.5

CHART 400-2