六、剛性鋪面之厚度設計法之建立

E 剛性鋪面之厚度設計法之建立

E.1 PCA厚度設計法之發展過程

資料來源：

Portland Cement Association, "Thickness Design for Concrete Highway and Street Pavements," Skokie, Illinois, 1984.

◎ PCA厚度設計法之回顧

※Fatigue Equation Recommended by PCA (Packard and Tayabji, 1985)

$$\begin{cases} \log \mathrm{N_f} = 11.737 - 12.077 * (\sigma_{eq} / S_c) & \text{for } \sigma_{eq} / S_c \geq 0.55 \\ \mathrm{N_f} = \left(\dfrac{4.2577}{\sigma_{eq} / S_C - 0.4325} \right)^{3.268} & \text{for } 0.45 < \sigma_{eq} / S_c < 0.55 \\ \mathrm{N_f} = \text{Unlimited} & \text{for } \sigma_{eq} / S_c \leq 0.45 \end{cases}$$

※ Equivalent Stress Calculations

1. J-SLAB F.E. analysis, E = 4 Mpsi, $\mu = 0.15$, L = 180 in., W = 144 in.
2. SA: 18-kip single axle load (dual wheels), P = 4,500 lbs, load area = 7*10 in.^{2} (or a = 4.72 in.), s = 12 in., D = 72 in.
3. TA: 36-kip tandem axle load (dual wheels), t = 50 in. and same remaining configurations
4. WS: a tied concrete shoulder (WS) was present, AGG = 25000 psi.

$$\sigma_{eq} = \frac{6 * M_e}{h^2} * f_1 * f_2 * f_3 * f_4$$

$$M_e = \begin{cases} -1600 + 2525*\log(\ell) + 24.42*\ell + 0.204*\ell^2 & \text{for SA/NS} \\ 3029 - 2966.8*\log(\ell) + 133.69*\ell - 0.0632*\ell^2 & \text{for TA/NS} \\ (-970.4 + 1202.6*\log(\ell) + 53.587*\ell) * (0.8742 + 0.01088*k^{0.447}) & \text{for SA/WS} \\ (2005.4 - 1980.9*\log(\ell) + 99.008*\ell) * (0.8742 + 0.01088*k^{0.447}) & \text{for TA/WS} \end{cases}$$

$$f_1 = \begin{cases} (24/SAL)^{0.06} * (SAL/18) & \text{for SA} \\ (48/TAL)^{0.06} * (TAL/36) & \text{for TA} \end{cases}$$

$$f_2 = \begin{cases} 0.892 + h/85.71 - h^2/3000 & \text{for NS} \\ 1 & \text{for WS} \end{cases}$$

$$f_3 = 0.894 \quad \text{for 6\% Truck at the Slab Edge}$$

$$f_4 = 1/[1.235*(1-CV)]$$

Where:

σ_{eq} = equivalent stress, $[FL^{-2}]$;

f_1 = adjustment factor for the effect of axle loads and contact areas;

f_2 = adjustment factor for a slab with no concrete shoulder based on the results of MATS computer program;

f_3 = adjustment factor to account for the effect of truck placement on the edge stress (PCA recommended a 6% truck encroachment, f_3=0.894);

f_4 = adjustment factor to account for the increase in concrete strength with age after the 28*th* day, along with a reduction in concrete strength by one coefficient of variation (CV); (PCA used CV=15%, f_4=0.953); and

SAL, TAL = actual single axle or tandem axle load, kips [F].

12.2.3 Design Procedure

The method presented in this section can be used when detailed axle load distributions have been determined or estimated, as described in Section 12.2.2. If the axle load data are not available, the simplified method presented in Section 12.2.4 should be used.

Design Tables and Charts

Separate sets of tables and charts are used to evaluate fatigue and erosion damages. The following parameter values are used in their development: elastic modulus of concrete = 4 × 10^6 psi (28 GPa), Poisson ratio of concrete = 0.15, diameter of dowels = $\frac{1}{8}$ in./in. of slab, spacing of dowels = 12 in. (305 mm), modulus of dowel support = 2 × 10^6 pci (543 GN/m^3), spring constant for aggregate interlock joints = 5000 psi (34.5 MPa), spring constant for tie concrete shoulder = 25,000 psi (173 MPa).

Fatigue Damage

Fatigue damage is based on the edge stress. Because the edge stress on mainline pavements without concrete shoulders is much greater than that with tied concrete shoulders, two different tables are needed: Table 12.6 for slabs without concrete shoulders and Table 12.7 for slabs with concrete shoulders. The equivalent stresses shown in these tables are the edge stresses multiplied by a factor of 0.894. It is not known what axle load was used to generate these stresses. Based on the levels of stress, it appears that an 18-kip (80-kN) load was used for single axles and a 36-kip (160-kN) load was used for tandem axles. Both tables show that the equivalent stresses under 36-kip (160-kN) tandem-axle loads are smaller than those under 18-kip (80-kN) single-axle loads, which is as expected.

After the equivalent stress is determined, the stress ratio factor can be computed by dividing the equivalent stress with the design modulus of rupture, so the allowable number of load repetitions can be obtained from Figure 12.12. Note that the reduction in the modulus of rupture by 15% and the increase in the modulus of rupture with age have been incorporated in the chart, so the user simply inputs the 28-day strength as the design modulus of rupture. Figure 12.12 can be applied to pavements both with and without concrete shoulders. If the allowable repetitions fall outside the range of the chart, the allowable number of repetitions is considered to be unlimited.

※ Design Procedures

1. Section 12.2.3 (Huang, p. 614): Design Tables and Fatigue damage
2. Equivalent Stress (Table 12.6 & Table 12.7)
3. Figure 12.12 Stress Ratio vs. Allowable load Repetitions
4. Table 12.11 (Erosion Factors)
5. Figure 12.14 Erosion Factors vs. Allowable load Repetitions
6. Figure 12.15 Worksheet for Sample Problem

Single Axle		Tandem Axle	
Load, kips	Axles / 1000 Trucks	Load, kips	Axles / 1000 Trucks
30	0.58	52	1.96
28	1.35	48	3.94
26	2.77	44	11.48
24	5.92	40	34.27
22	9.83	36	81.42
20	21.67	32	85.54
18	28.24	28	152.23
16	38.83	24	90.52
14	53.94	20	112.81
12	168.85	16	124.69

參考資料：

1. Huang, Y. H., Pavement Analysis and Design, 1993. (Chapter 12)
2. 周義華，運輸工程，1993。(第十章)

TABLE 12.6 EQUIVALENT STRESSES FOR SLABS WITHOUT CONCRETE SHOULDERS

Slab thickness (in.)	k of Subgrade–subbase (pci)						
	50	100	150	200	300	500	700
4	825/679	726/585	671/542	634/516	584/486	523/457	484/443
4.5	699/586	616/500	571/460	540/435	498/406	448/378	417/363
5	602/516	531/436	493/399	467/376	432/349	390/321	363/307
5.5	526/461	464/387	431/353	409/331	379/305	343/278	320/264
6	465/416	411/348	382/316	362/296	336/271	304/246	285/232
6.5	417/380	367/317	341/286	324/267	300/244	273/220	256/207
7	375/349	331/290	307/262	292/244	271/222	246/199	231/186
7.5	340/323	300/268	279/241	265/224	246/203	224/181	210/169
8	311/300	274/249	255/223	242/208	225/188	205/167	192/155
8.5	285/281	252/232	234/208	222/193	206/174	188/154	177/143
9	264/264	232/218	216/195	205/181	190/163	174/144	163/133
9.5	245/248	215/205	200/183	190/170	176/153	161/134	151/124
10	228/235	200/193	186/173	177/160	164/144	150/126	141/117
10.5	213/222	187/183	174/164	165/151	153/136	140/119	132/110
11	200/211	175/174	163/155	154/143	144/129	131/113	123/104
11.5	188/201	165/165	153/148	145/136	135/122	123/107	116/98
12	177/192	155/158	144/141	137/130	127/116	116/102	109/93
12.5	168/183	147/151	136/135	129/124	120/111	109/97	103/89
13	159/176	139/144	129/129	122/119	113/106	103/93	97/85
13.5	152/168	132/138	122/123	116/114	107/102	98/89	92/81
14	144/162	125/133	116/118	110/109	102/98	93/85	88/78

Note. Number at left is for single axle and number at right is for tandem axle (single/tandem); 1 in. = 25.4 mm, 1 pci = 271.3 kN/m^3.

Source. After PCA (1984).

TABLE 12.7 EQUIVALENT STRESSES FOR SLABS WITH CONCRETE SHOULDERS

Slab thickness (in.)	k of Subgrade–subbase (pci)						
	50	100	150	200	300	500	700
4	640/534	559/468	517/439	489/422	452/403	409/388	383/384
4.5	547/461	479/400	444/372	421/356	390/338	355/322	333/316
5	475/404	417/349	387/323	367/308	341/290	311/274	294/267
5.5	418/360	368/309	342/285	324/271	302/254	276/238	261/231
6	372/325	327/277	304/255	289/241	270/225	247/210	234/203
6.5	334/295	294/251	274/230	260/218	243/203	223/188	212/180
7	302/270	266/230	248/210	236/198	220/184	203/170	192/162
7.5	275/250	243/211	226/193	215/182	201/168	185/155	176/148
8	252/232	222/196	207/179	197/168	185/155	170/142	162/135
8.5	232/216	205/182	191/166	182/156	170/144	157/131	150/125
9	215/202	190/171	177/155	169/146	158/134	146/122	139/116
9.5	200/190	176/160	164/146	157/137	147/126	136/114	129/108
10	186/179	164/151	153/137	146/129	137/118	127/107	121/101
10.5	174/170	154/143	144/130	137/121	128/111	119/101	113/95
11	164/161	144/135	135/123	129/115	120/105	112/95	106/90
11.5	154/153	136/128	127/117	121/109	113/100	105/90	100/85
12	145/146	128/122	120/111	114/104	107/95	99/86	95/81
12.5	137/139	121/117	113/106	108/99	101/91	94/82	90/77
13	130/133	115/112	107/101	102/95	96/86	89/78	85/73
13.5	124/127	109/107	102/97	97/91	91/83	85/74	81/70
14	118/122	104/103	97/93	93/87	87/79	81/71	77/67

Note. Number at left is for single axle and number at right is for tandem axle (single/tandem); 1 in. = 25.4 mm, 1 pci = 271.3 kN/m^3.

Source. After PCA (1984).

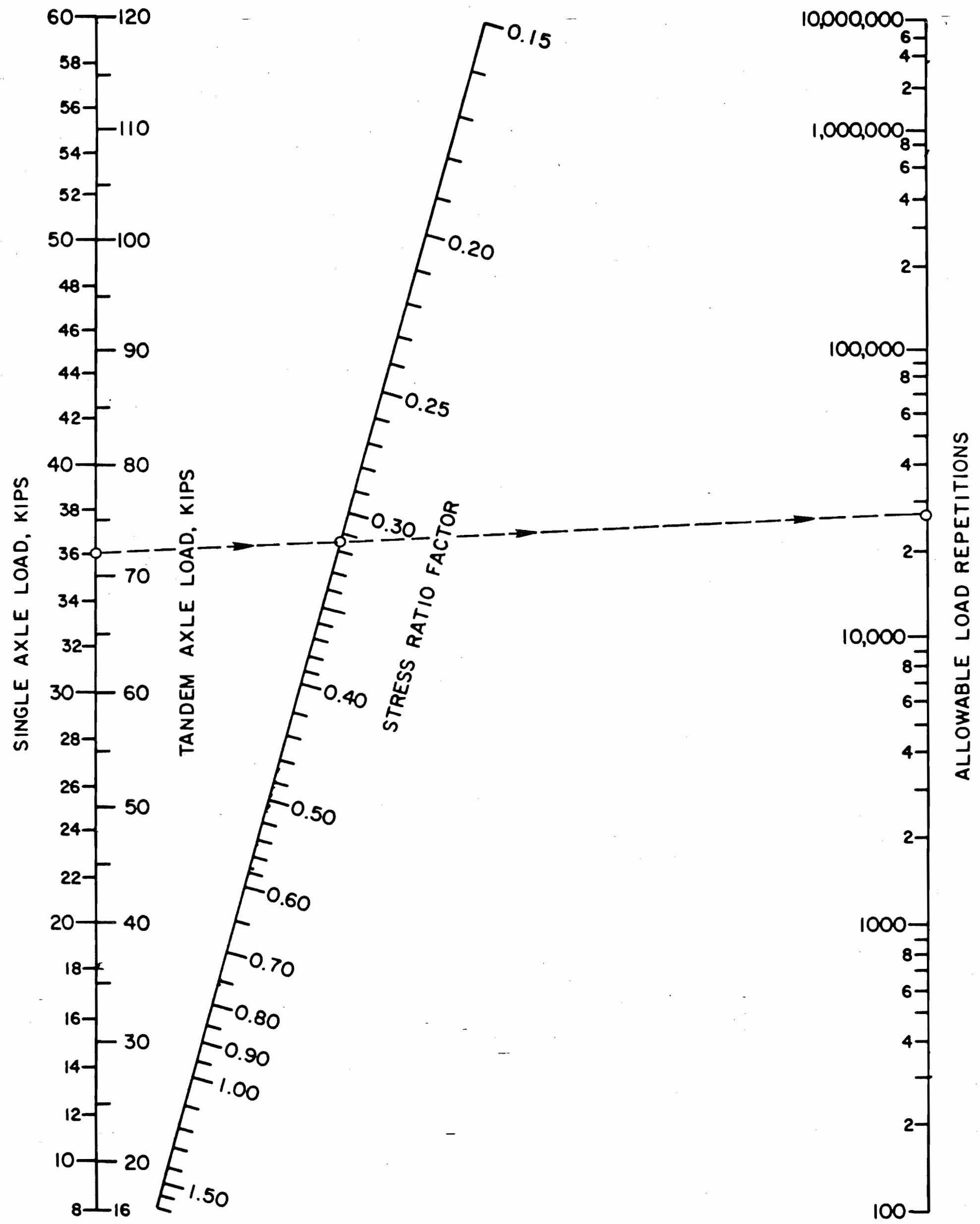


Figure 12.12 Stress ratio factors versus allowable load repetitions both with and without concrete shoulders (1 kip = 4.45 kN). (After PCA (1984).)

Calculation of Pavement Thickness

Project Design 1A, four-lane Interstate, rural

Trial thickness 9.5 in.
Subbase-subgrade *k* 130 pci
Modulus of rupture, MR 650 psi
Load safety factor, LSF 1.2

Doweled joints: yes ✓ no
Concrete shoulder: yes no ✓
Design period 20 years

4 in. untreated subbase

Axle load, kips	Multiplied by LSF 1.2	Expected repetitions	Fatigue analysis		Erosion analysis	
			Allowable repetitions	Fatigue, percent	Allowable repetitions	Damage, percent
1	2	3	4	5	6	7

8. Equivalent stress 206
9. Stress ratio factor 0.317
10. Erosion factor 2.59

Single Axles

30	36.0	6,310	27,000	23.3	1,500,000	0.4
28	33.6	14,690	77,000	19.1	2,200,000	0.7
26	31.2	30,140	230,000	13.1	3,500,000	0.9
24	28.8	64,410	1,200,000	5.4	5,900,000	1.1
22	26.4	106,900	Unlimited	0	11,000,000	1.0
20	24.0	235,800	"	0	23,000,000	1.0
18	21.6	307,200	"	0	64,000,000	0.5
16	19.2	422,500			Unlimited	0
14	16.8	586,900			"	0
12	14.4	1,837,000			"	0

11. Equivalent stress 192
12. Stress ratio factor 0.295
13. Erosion factor 2.79

Tandem Axles

52	62.4	21,320	1,100,000	1.9	920,000	2.3
48	57.6	42,870	Unlimited	0	1,500,000	2.9
44	52.8	124,900	"	0	2,500,000	5.0
40	48.0	372,900	"	0	4,600,000	8.1
36	43.2	885,800			9,500,000	9.3
32	38.4	930,700			24,000,000	3.9
28	33.6	1,656,000			92,000,000	1.8
24	28.8	984,900			Unlimited	0
20	24.0	1,227,000			"	0
16	19.2	1,356,000				
			Total	62.8	Total	38.9

Figure 12.15 Worksheet for sample problem (1 in. = 25.4 mm, 1 psi = 6.9 kPa, 1 pci = 271.3 kN/m^3). (After PCA (1984).)

5. The fatigue percentages are obtained by dividing column 3 with column 4 and multiplying by 100. The sum of fatigue percentages over all single- and tandem-axle loads is entered at the bottom.
6. The allowable repetitions in erosion analysis are obtained from Figure 12.13 based on an erosion factor of 2.59 for single axles and 2.79 for tandem axles.
7. The erosion percentages are obtained by dividing column 3 with column 6 and multiplying by 100. The sum of erosion percentages over all single- and tandem-axle loads is entered at the bottom.

Figure 12.15 shows that damages caused by fatigue and erosion are 62.8 and 38.9, respectively. Since both are less than 100%, the use of 9.5 in. (241 mm) slab is quite adequate. Separate calculations showed that a slab of 9.0 in. (229 mm) was not adequate because the fatigue damage would increase to 142%. Therefore, this design is controlled by the fatigue analysis.

TABLE 12.11 EROSION FACTORS FOR SLABS WITH AGGREGATE INTERLOCK JOINTS AND CONCRETE SHOULDERS

Slab thickness (in.)	k of Subgrade–subbase (pci)					
	50	100	200	300	500	700
4	3.46/3.49	3.42/3.39	3.38/3.32	3.36/3.29	3.32/3.26	3.28/3.24
4.5	3.32/3.39	3.28/3.28	3.24/3.19	3.22/3.16	3.19/3.12	3.15/3.09
5	3.20/3.30	3.16/3.18	3.12/3.09	3.10/3.05	3.07/3.00	3.04/2.97
5.5	3.10/3.22	3.05/3.10	3.01/3.00	2.99/2.95	2.96/2.90	2.93/2.86
6	3.00/3.15	2.95/3.02	2.90/2.92	2.88/2.87	2.86/2.81	2.83/2.77
6.5	2.91/3.08	2.86/2.96	2.81/2.85	2.79/2.79	2.76/2.73	2.74/2.68
7	2.83/3.02	2.77/2.90	2.73/2.78	2.70/2.72	2.68/2.66	2.65/2.61
7.5	2.76/2.97	2.70/2.84	2.65/2.72	2.62/2.66	2.60/2.59	2.57/2.54
8	2.69/2.92	2.63/2.79	2.57/2.67	2.55/2.61	2.52/2.53	2.50/2.48
8.5	2.63/2.88	2.56/2.74	2.51/2.62	2.48/2.55	2.45/2.48	2.43/2.43
9	2.57/2.83	2.50/2.70	2.44/2.57	2.42/2.51	2.39/2.43	2.36/2.38
9.5	2.51/2.79	2.44/2.65	2.38/2.53	2.36/2.46	2.33/2.38	2.30/2.33
10	2.46/2.75	2.39/2.61	2.33/2.49	2.30/2.42	2.27/2.34	2.24/2.28
10.5	2.41/2.72	2.33/2.58	2.27/2.45	2.24/2.38	2.21/2.30	2.19/2.24
11	2.36/2.68	2.28/2.54	2.22/2.41	2.19/2.34	2.16/2.26	2.14/2.20
11.5	2.32/2.65	2.24/2.51	2.17/2.38	2.14/2.31	2.11/2.22	2.09/2.16
12	2.28/2.62	2.19/2.48	2.13/2.34	2.10/2.27	2.06/2.19	2.04/2.13
12.5	2.24/2.59	2.15/2.45	2.09/2.31	2.05/2.24	2.02/2.15	1.99/2.10
13	2.20/2.56	2.11/2.42	2.04/2.28	2.01/2.21	1.98/2.12	1.95/2.06
13.5	2.16/2.53	2.08/2.39	2.00/2.25	1.97/2.18	1.93/2.09	1.91/2.03
14	2.13/2.51	2.04/2.36	1.97/2.23	1.93/2.15	1.89/2.06	1.87/2.00

Note. Number at left is for single axle and number at right is for tandem axle (single/tandem); 1 in. = 25.4 mm, 1 pci = 271.3 kN/m^3.

Source. After PCA (1984).

Explanation of Worksheet

1. Single-axle loads are incremented at 2-kip (8.9-kN) intervals, and tandem-axle loads are incremented at 4-kip (17.8-kN) intervals. The largest load in the single- or tandem-load group should be entered first. If the allowable number of repetitions for a given load is unlimited, it is not necessary to compute the damage for the remaining loads in the same group.
2. The axle loads in column 1 are multiplied by a load safety factor of 1.2.
3. The predicted or expected repetitions are obtained from Table 12.5. To be on the conservative side, the upper limit of the load in the range is used to represent the range. For example, all axle loads between 28 and 30 kip (125 and 134 kN) are considered as 30 kip (134 kN). With an annual growth rate of 4% and a design period of 20 years, from Table 6.12, growth factor $G = 1.5$. Design ADT = 12,900 × 1.5 = 19,350, or 9675 in one direction. ADTT = 19,350 × 0.19 = 3680, or 1840 in one direction. For an ADT of 9675 in one direction, from Figure 6.8, lane distribution factor $L = 0.81$. Therefore, the total number of trucks on the design lane during the design period is 1840 ×

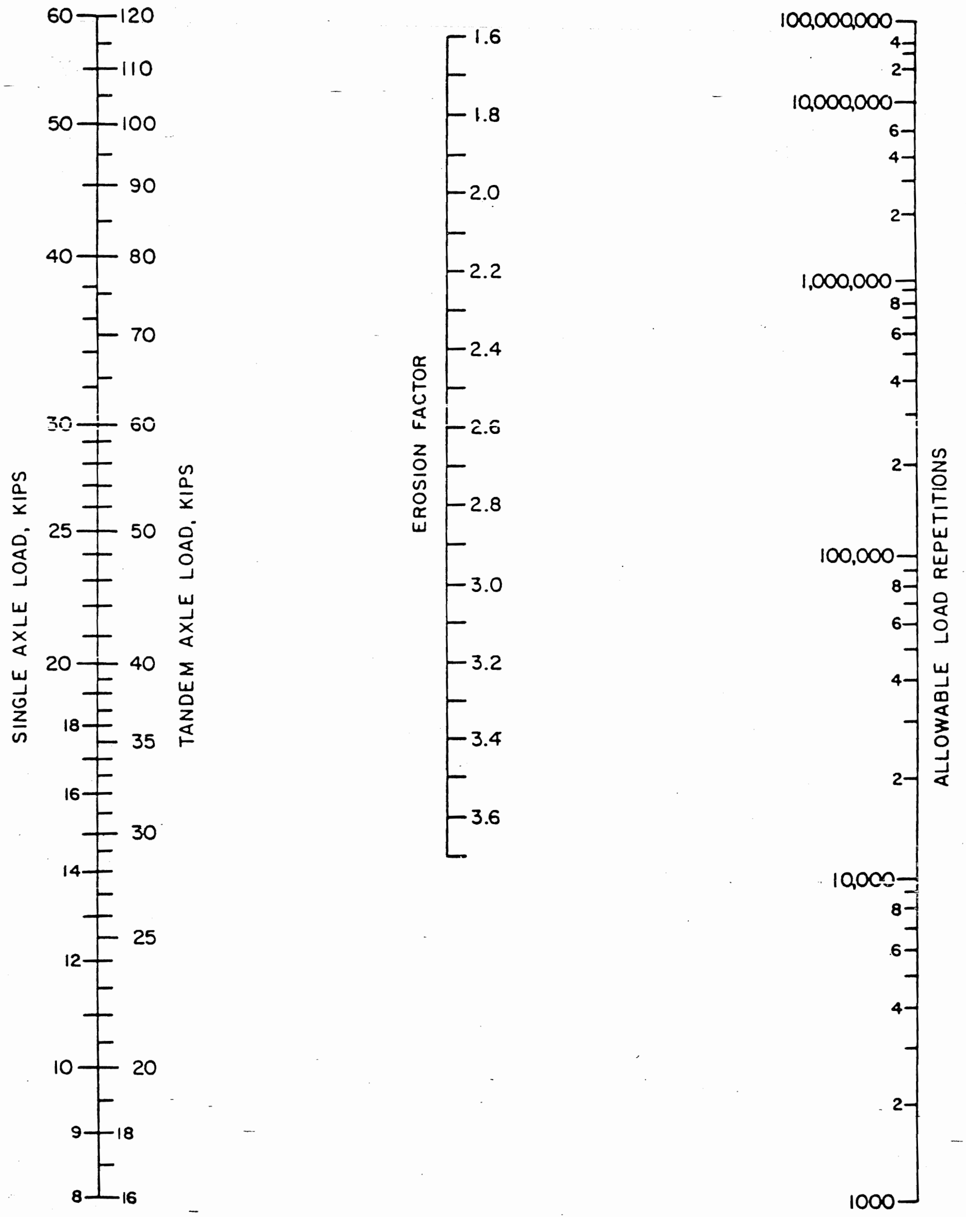


Figure 12.14 Erosion factors versus allowable load repetitions with concrete shoulders (1 kip = 4.45 kN). (After PCA (1984).)

0.81 × 365 × 20 = 10,880,000, which was used to obtain the axle load distribution in Table 12.5.

4. The allowable repetitions in fatigue analysis are obtained from Figure 12.12 based on a stress ratio factor of 206/650, or 0.317, for single axles and 192/650, or 0.295, for tandem axles.

◎ **PCA厚度設計法之發展過程**

1. **Warping & curling are excluded.**
2. **Edge stress (load only)**
3. **Truck load placement:**
   - **(a) Considering edge loading only and placing 6% of the total load repetitions at pavement edge**
   - **(b) Or use total number of repetitions for design but reduce edge stress to obtain same fatigue.**
4. **6% truck encroachment ➔ adjustment factor=0.894**

E.4 Modified PCA Stress Analysis and Thickness Design Procedures

資料來源：

Lee, Y. H., J.. H. Bair, C. T. Lee, S. T. Yen, Y. M. Lee, "Modified PCA Stress Analysis and Thickness Design Procedures," Presented at the 76th Annual Meeting of the Transportation Research Board and Accepted for Publication in the Future Transportation Research Record, 1997.

◎Demo. Of TKUPAV program

HW#5：

Validate your ILLI-SLAB stress analysis results using TKUPAV program (edge stress & interior stress).

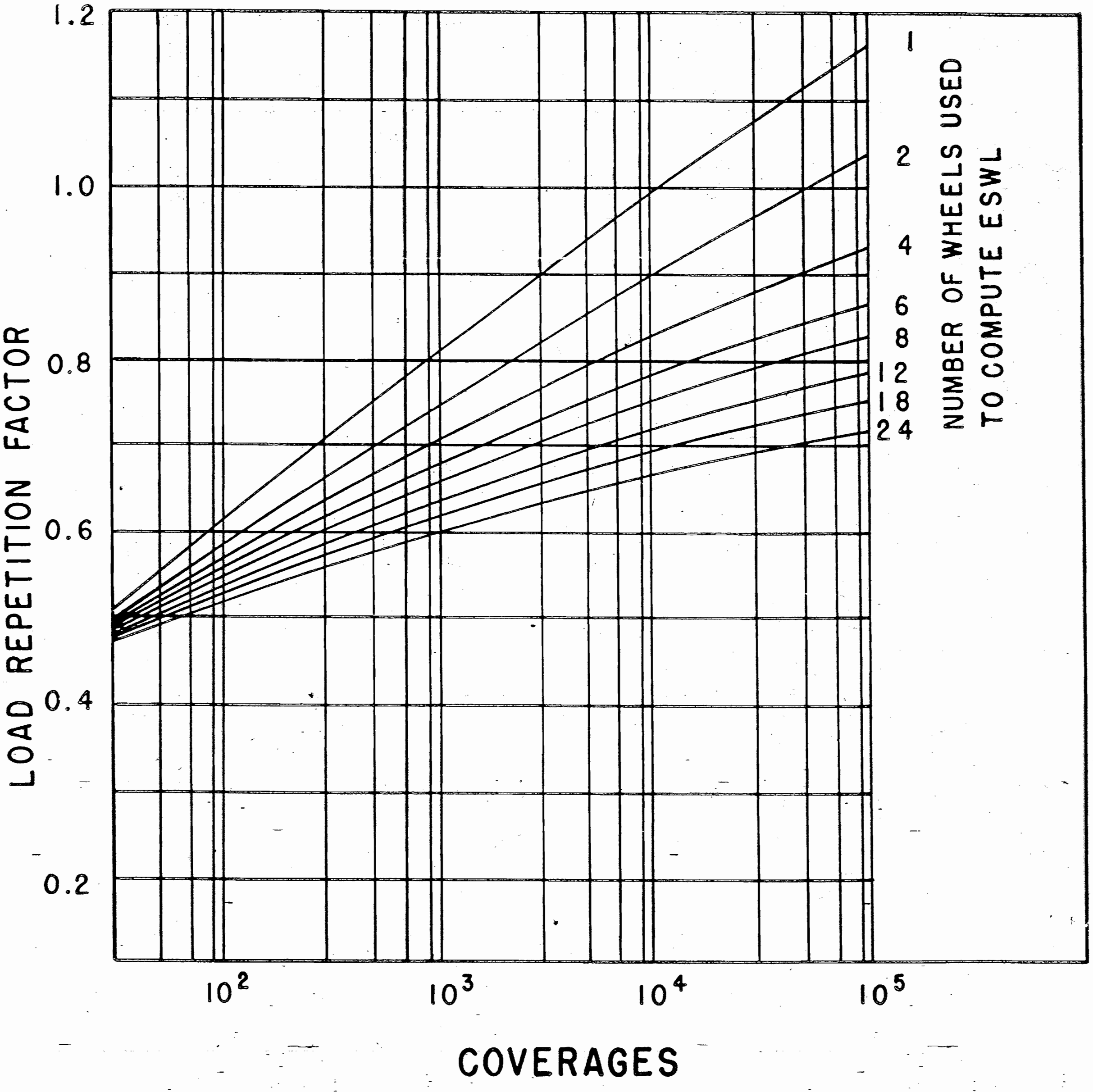
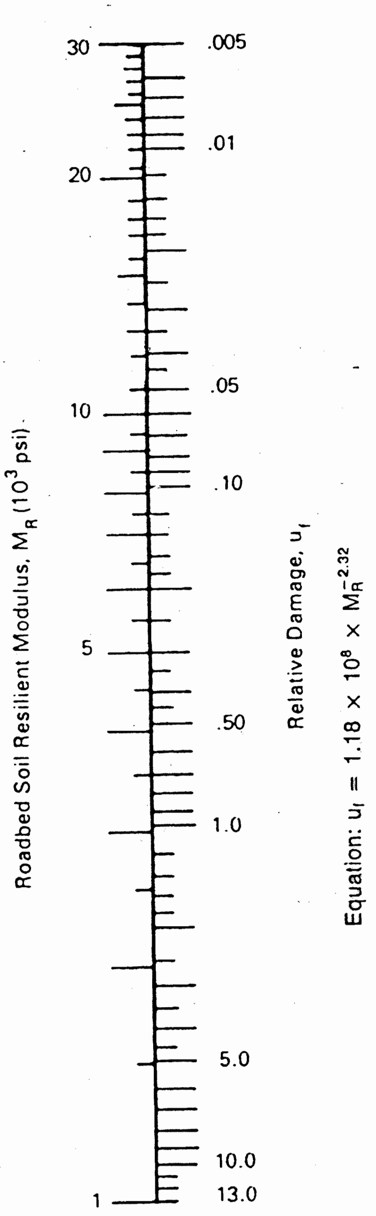


FIGURE 3. LOAD REPETITION FACTOR VS. COVERAGES

Month	Roadbed Soil Modulus, M_R (psi)	Relative Damage, u_f
Jan.	20,000	0.01
Feb.	20,000	0.01
Mar.	2,500	1.51
Apr.	4,000	0.51
May	4,000	0.51
June	7,000	0.13
July	7,000	0.13
Aug.	7,000	0.13
Sept.	7,000	0.13
Oct.	7,000	0.13
Nov.	4,000	0.51
Dec.	20,000	0.01
	Summation: Σu_f =	3.72



Average: $\bar{u}_f = \frac{\Sigma u_f}{n} = \frac{3.72}{12} = 0.31$

Effective Roadbed Soil Resilient Modulus, M_R (psi) = 5,000 (corresponds to $\bar{u}_f$)

2.4. Chart for Estimating Effective Roadbed Soil Resilient Modulus for Flexible Pavements Designed Using the Serviceability Criteria traffic away from the edge may be treated as a tied shoulder.

2.4.3 Loss of Support

This factor, LS, is included in the design of rigid pavements to account for the potential loss of support arising from subbase erosion and/or differential vertical soil movements. It is treated in the actual design procedure (discussed in Part II, Chapter 3) by diminishing the effective or composite k-value based on the size of the void that may develop beneath the slab. Table 2.7 provides some suggested ranges of LS depending on the type of material (specifically its stiffness or elastic modulus). Obviously, if various types of base or subbase are to be considered for design, then the corresponding values of LS should be determined for each type. A discussion of how the loss of support factor was derived is present in Appendix LL of Volume 2 of this Guide.

The LS factor should also be considered in terms of differential vertical soil movements that may result in voids beneath the pavement. Thus, even though a nonerosive subbase is used, a void may still develop, thus reducing pavement life. Generally, for active swelling clays or excessive frost heave, LS values of 2.0 to 3.0 may be considered. Each agency's experience in this area should, however, be the key element in the selection of an appropriate LS value. Examination of the effect of LS on reducing the effective k-value of the roadbed soil (see Figure 3.6) may also be helpful in selecting an appropriate value.

Table 2.7. Typical Ranges of Loss of Support (LS) Factors for Various Types of Materials (*6*)

Type of Material	Loss of Support (LS)
Cement Treated Granular Base (E = 1,000,000 to 2,000,000 psi)	0.0 to 1.0
Cement Aggregate Mixtures (E = 500,000 to 1,000,000 psi)	0.0 to 1.0
Asphalt Treated Base (E = 350,000 to 1,000,000 psi)	0.0 to 1.0
Bituminous Stabilized Mixtures (E = 40,000 to 300,000 psi)	0.0 to 1.0
Lime Stabilized (E = 20,000 to 70,000 psi)	1.0 to 3.0
Unbound Granular Materials (E = 15,000 to 45,000 psi)	1.0 to 3.0
Fine Grained or Natural Subgrade Materials (E = 3,000 to 40,000 psi)	2.0 to 3.0

NOTE: E in this table refers to the general symbol for elastic or resilient modulus of the material.

2.5 REINFORCEMENT VARIABLES

Because of the difference in the reinforcement design procedures between jointed and continuous pavements, the design requirements for each are separated into two sections. Information is also provided here for the design of prestressed concrete pavement. In addition to dimensions, consideration should be given to corrosion resistance of reinforcement, especially in areas where pavements are exposed to variable moisture contents and salt applications.

2.5.1 Jointed Reinforced Concrete Pavements

There are two types of rigid pavement which fall under the "jointed" category: plain jointed pavement (JCP), which is designed not to have steel reinforcement, and jointed reinforced concrete pavement (JRCP), which is designed to have significant steel reinforcement, in terms of either steel bars or welded steel mats. The steel reinforcement is added if the probability of transverse cracking during pavement life is high due to such factors as soil movement and/or temperature/moisture change stresses.

For the case of plain jointed concrete pavements (JCP), the joint spacing should be selected at values so that temperature and moisture change stresses do not produce intermediate cracking between joints. The maximum joint spacing will vary, depending on local conditions, subbase types, coarse aggregate types, etc. In addition, the maximum joint spacing may be selected to minimize joint movement and, consequently, maximize load transfer. Each agency's experience should be relied on for this selection.

Following are the criteria needed for the design of jointed pavements which are steel reinforced (JRCP). These criteria apply to the design of both longitudinal and transverse steel reinforcement.

Slab Length. This refers to the joint spacing or distance, L (feet), between free (i.e., untied) transverse joints. It is an important design consideration since it has a large impact on the maximum concrete tensile stresses and, consequently, the amount of steel

Example:

D_{SB} = 6 inches

E_{SB} = 20,000 psi

M_R = 7,000 psi

Solution: k_∞ = 400 pci

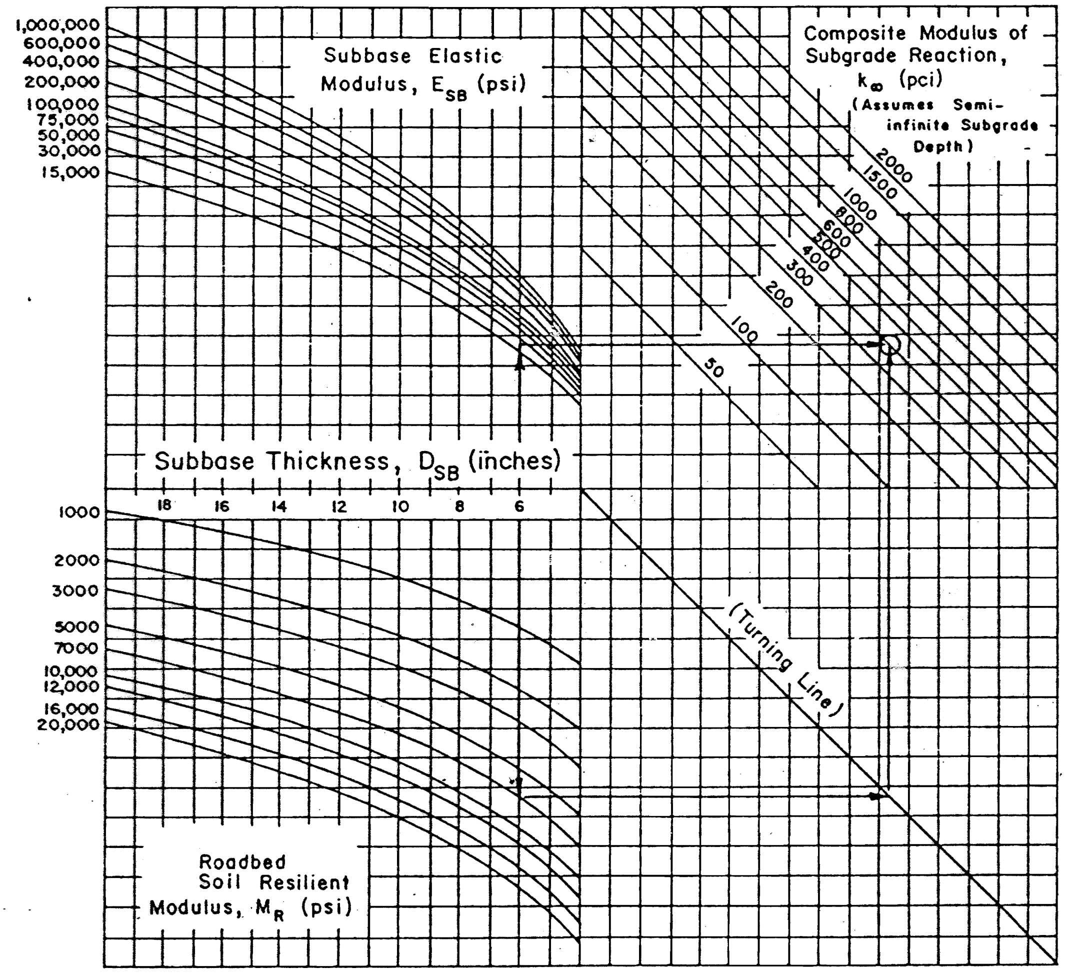
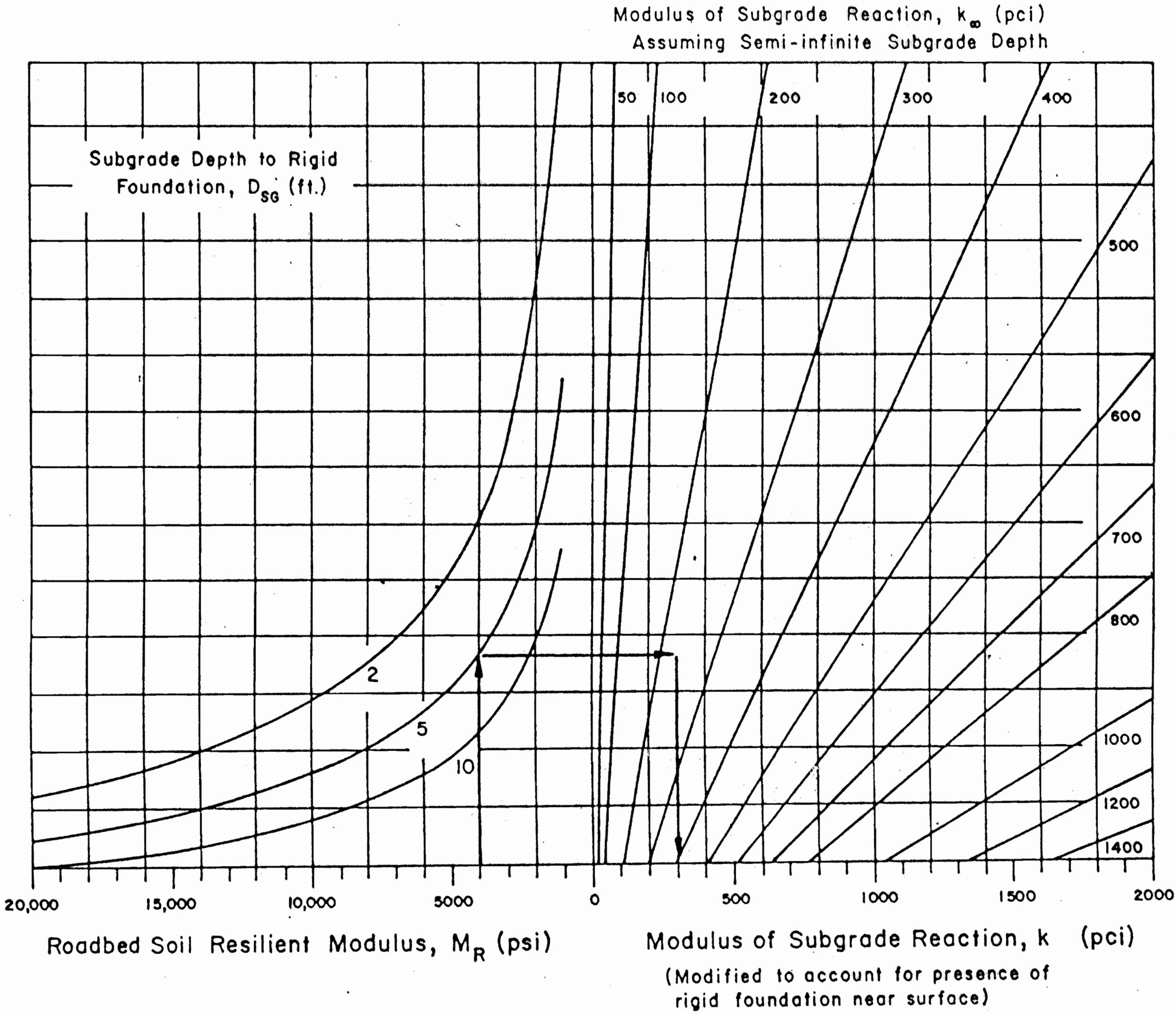


Figure 3.3. Chart for Estimating Composite Modulus of Subgrade Reaction, k_∞, Assuming a Semi-Infinite Subgrade Depth. (For practical purposes, a semi-infinite depth is considered to be greater than 10 feet below the surface of the subgrade.)



Example:

M_R = 4000 psi
D_{SG} = 5 ft.
k_∞ = 230 pci
Solution: k = 300 pci

Figure 3.4. Chart to Modify Modulus of Subgrade Reaction to Consider Effects of Rigid Foundation Near Surface (within 10 feet)

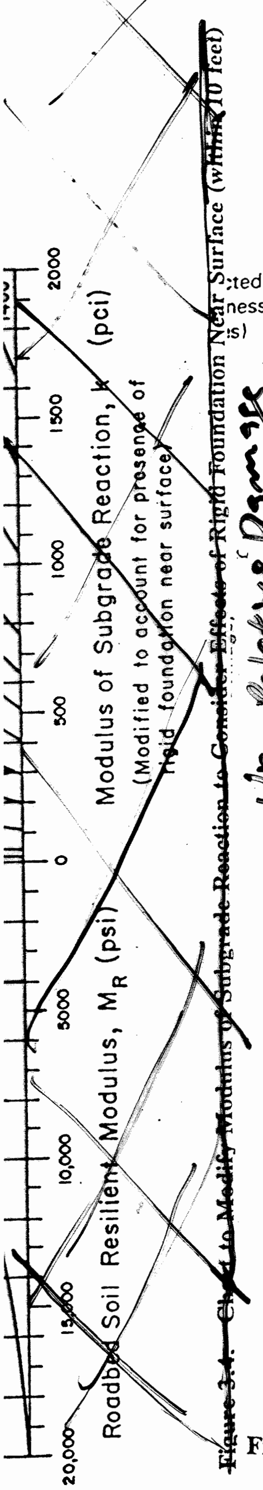


Figure 3.4. Chart to Modify Modulus of Subgrade Reaction to Consider Effects of Rigid Foundation Near Surface (within 10 feet)

Ur Relative Damage

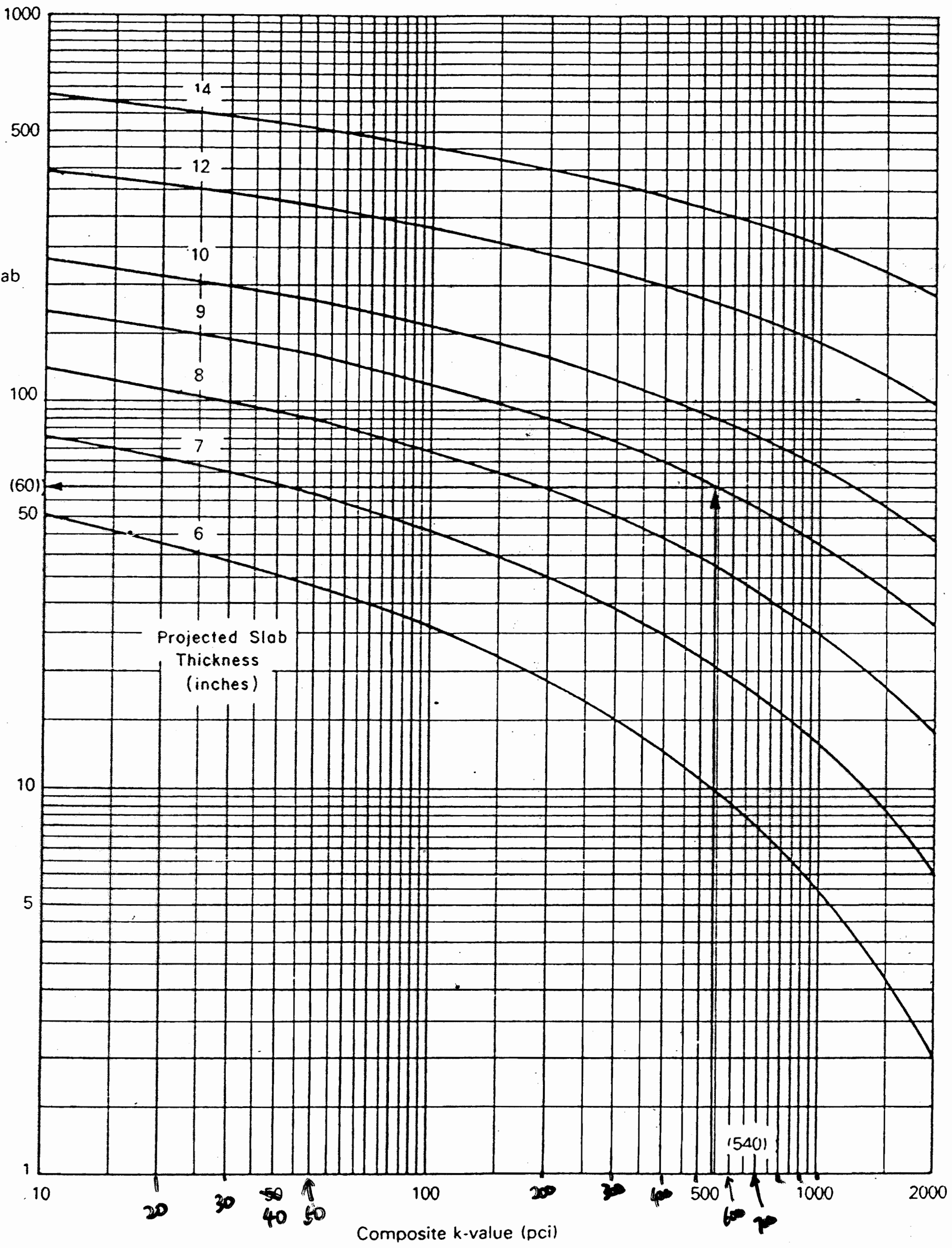


Figure 3.5. Chart for Estimating Relative Damage to Rigid Pavements Based on Slab Thickness and Underlying Support

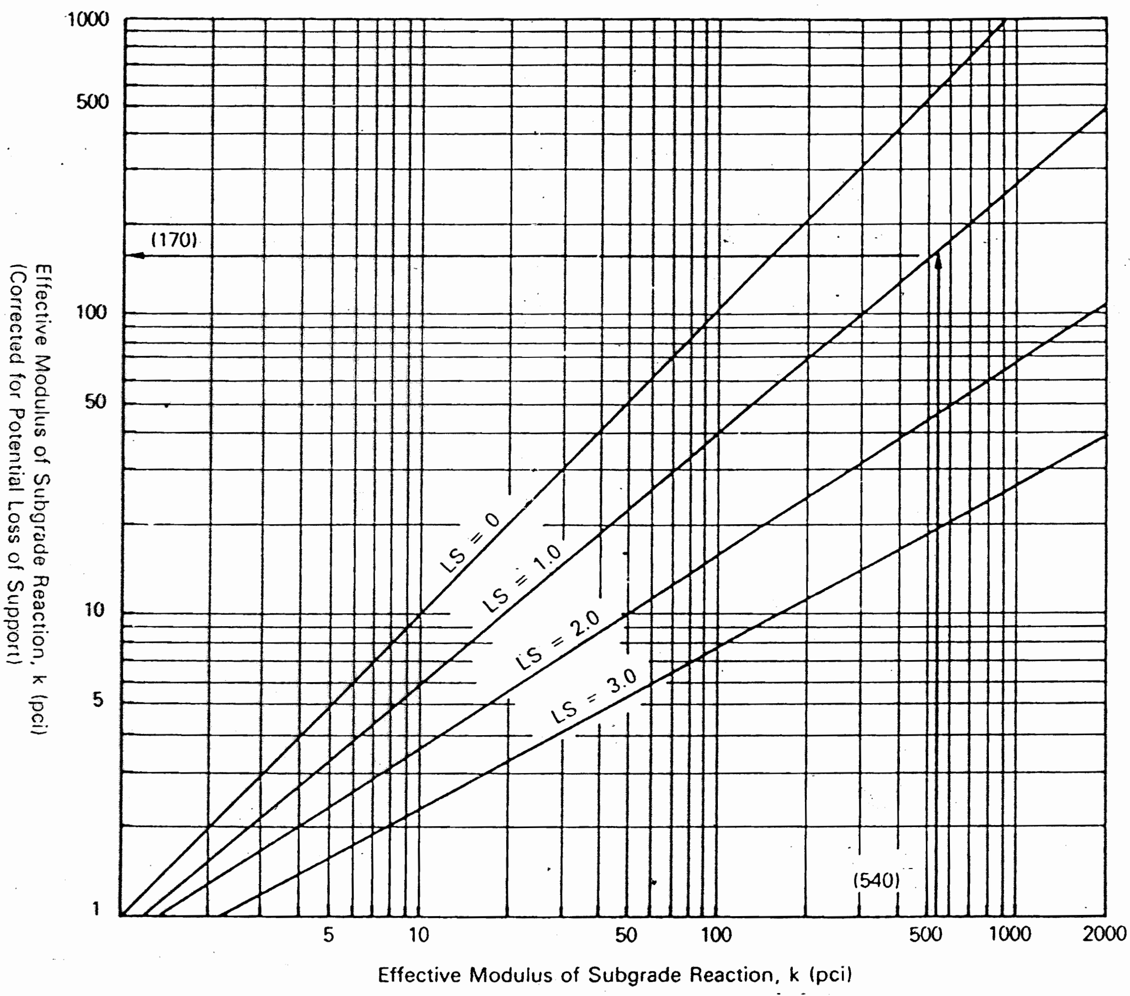


Figure 3.6. Correction of Effective Modulus of Subgrade Reaction for Potential Loss of Subbase Support (*6*)

Table 3.3. Example Application of Method for Estimating Effective Modulus of Subgrade Reaction

Trial Subbase: Type Granular

Thickness (inches) 6

Loss of Support, LS 1.0

Depth to Rigid Foundation (feet) 5

Projected Slab Thickness (inches) 9

(1)	(2)	(3)	(4)	(5)	(6)
Month	**Roadbed Modulus, M_R (psi)**	**Subbase Modulus, E_{SB} (psi)**	**Composite k-Value (pci) (Fig. 3.3)**	**k-Value (pci) on Rigid Foundation (Fig. 3.4)**	**Relative Damage, u_r (Fig. 3.5)**
Jan.	20,000	50,000	1,100	1,350	0.35
Feb.	20,000	50,000	1,100	1,350	0.35
Mar.	2,500	15,000	160	230	0.86
Apr.	4,000	15,000	230	300	0.78
May	4,000	15,000	230	300	0.78
June	7,000	20,000	410	540	0.60
July	7,000	20,000	410	540	0.60
Aug.	7,000	20,000	410	540	0.60
Sept.	7,000	20,000	410	540	0.60
Oct.	7,000	20,000	410	540	0.60
Nov.	4,000	15,000	230	300	0.78
Dec.	20,000	50,000	1,100	1,350	0.35

Summation: $\Sigma u_r =$ 7.25

Average: $\bar{u}_r = \frac{\Sigma u_r}{n} = \frac{7.25}{12} = 0.60$

Effective Modulus of Subgrade Reaction, k (pci) = 540

Corrected for Loss of Support: k (pci) = 170