

2.6.2 Rigid Pavement

This type of pavement consists of concrete slab and base course (when used in rigid pavement it is called subbase course). These two layers are resting on subgrade soil.

2.6.2.1 Rigid Pavement Types

1. Jointed plain concrete pavement (JPCP)
2. Jointed reinforced concrete pavement (JRCP)
3. Continuous reinforced concrete pavement (CRCP)
4. Prestressed concrete pavements

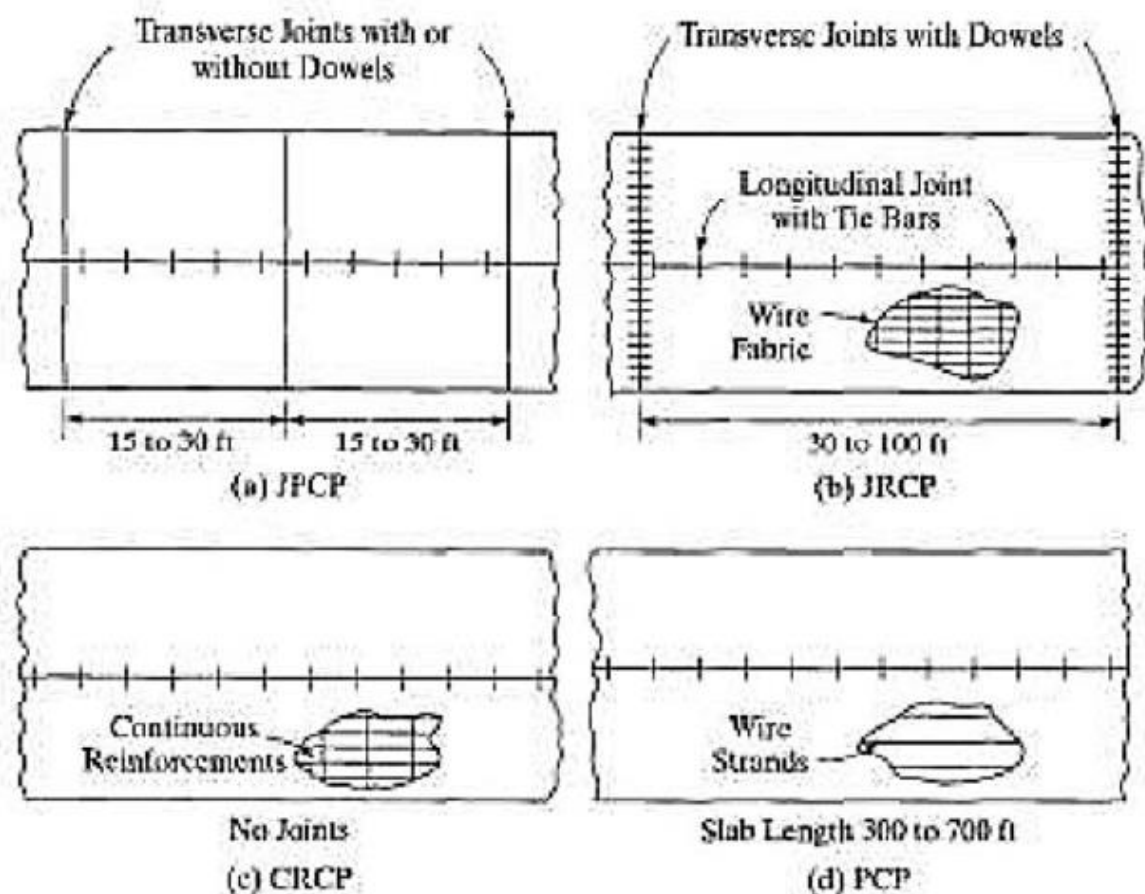


Figure 2.18: Different concrete pavement types (plan views)

2.6.2.2 Rigid Pavement Reinforcements

1. Temperature reinforcement (wire fabric)
2. Tie bars (1- Prevent lanes from separation and differential deflection. 2- Reduce transverse cracking)
3. Dowel bars (1- Minimise deflections and reduce stresses near the edges of the slabs. 2- Transferee load from one slab to another without preventing the joint from opening)

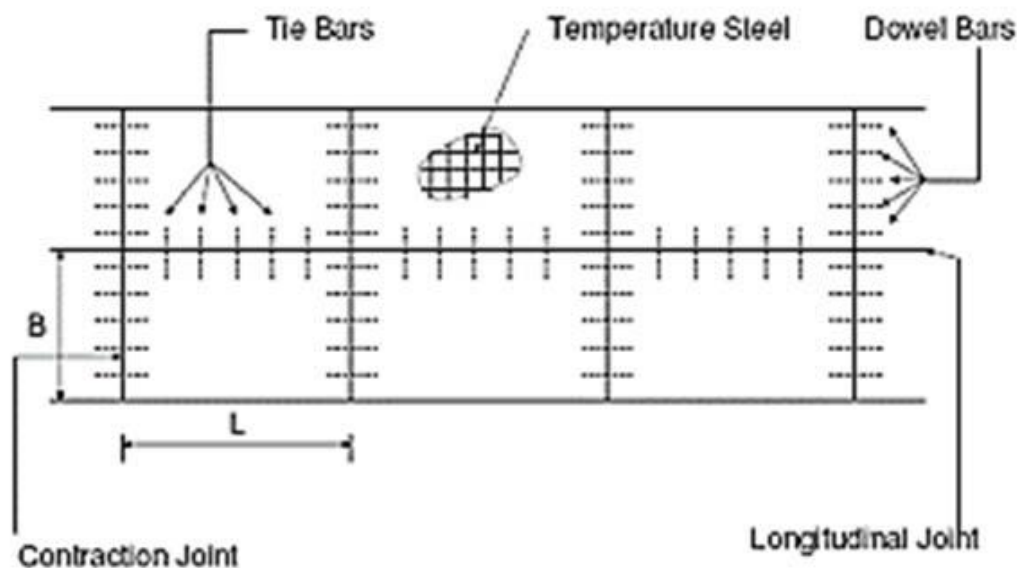


Figure 2.19: Reinforcement illustration and general appearance of concrete pavement

2.6.2.3 Joints in rigid pavement

1. Expansion joints

It is placed at a specific location to allow the pavement to expand without damaging adjacent structures or the pavement itself as shown in Figure 2.20

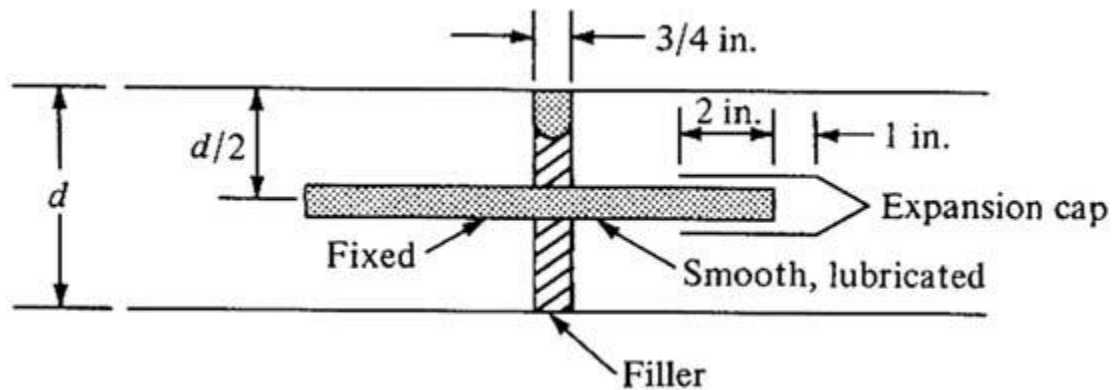


Figure 2.20: Expansion joint

2. Contraction joint

is a sawed, formed, or tooled groove in a concrete slab that creates a weakened vertical plane. It regulates the location of the cracking caused by dimensional changes in the slab.

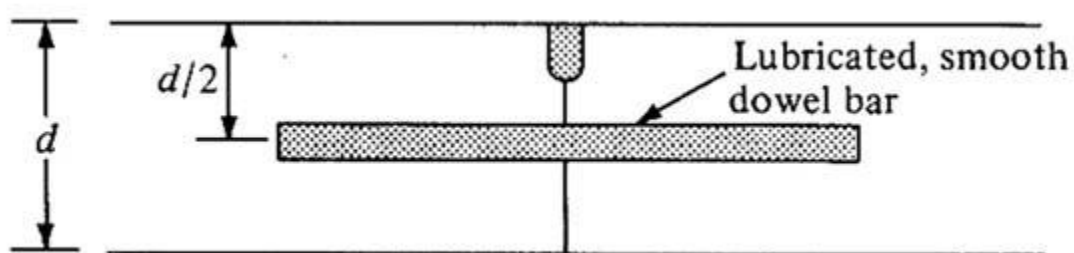


Figure 2.21: Contraction joint

3. Construction joints

It is a joint between slabs that results when concrete is placed at different times.

Figure 2.22 shows this type of joint.

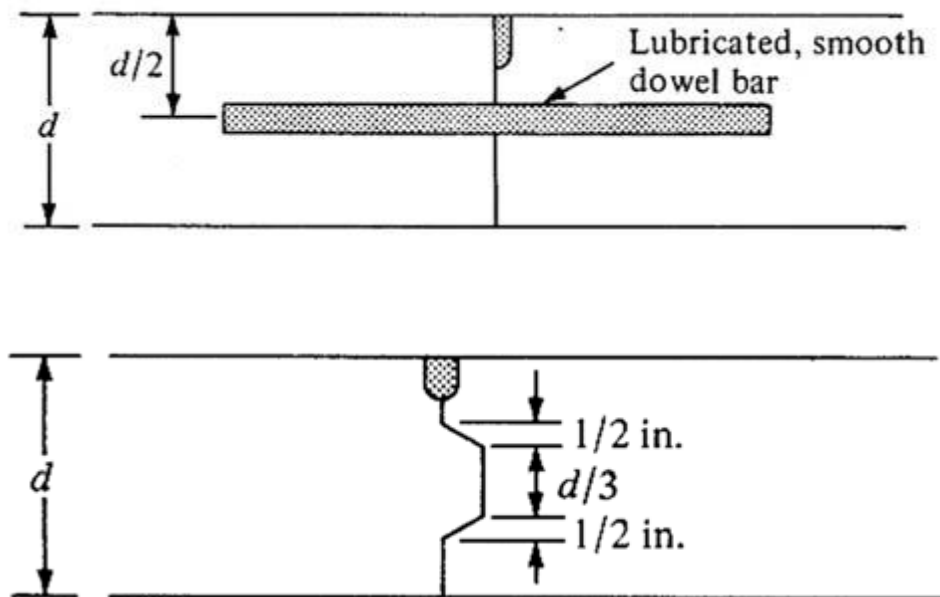


Figure 2.22: Construction joint

2.6.2.4 AASHTO 1993 thickness design method

In design of rigid pavement, AASHTO design method consider many factors. These are:

1. Pavement performance.
2. Subbase strength.
3. Subgrade strength.
4. Traffic.
5. Concrete properties.
6. Drainage.
7. Reliability.

Pavement performance

This factor is considered in similar way of that discussed in flexible pavement. However, the initial serviceability index (p_i) is taken as 4.5. Final serviceability index value is as discussed in flexible pavement design.

Subbase strength

AASHTO 1993 design guide allow using of six subbase types (A to F) ranging from granular to stabilized materials. The requirements needed for these types are shown in Table 2.10. The minimum thickness as suggested by AASHTO method should not be less than 6 inches and this should be extended 1-3 ft outside pavement edges. Subbase materials is characterized by its elastic modulus E_{SB} .

Table 2.10: Recommended particle size distributions for different types of subbase materials

Sieve Designation	Types of Subbase					
	Type A	Type B	Type C (Cement Treated)	Type D (Lime Treated)	Type E (Bituminous Treated)	Type F (Granular)
Sieve analysis percent passing						
2 in.	100	100	—	—	—	—
1 in.	—	75–95	100	100	100	100
¾ in.	30–65	40–75	50–85	60–100	—	—
No. 4	25–55	30–60	35–65	50–85	55–100	70–100
No. 10	15–40	20–45	25–50	40–70	40–100	55–100
No. 40	8–20	15–30	15–30	25–45	20–50	30–70
No. 200	2–8	5–20	5–15	5–20	6–20	8–25
(The minus No. 200 material should be held to a practical minimum.)						
Compressive strength lb/in ² at 28 days			400–750	100		
Stability						
Hveem Stabilometer					20 min	
Hubbard field					1000 min	
Marshall stability					500 min	
Marshall flow					20 max	
Soil constants						
Liquid limit	25 max	25 max				25 max
Plasticity index ^a	N.P.	6 max	10 max ^b		6 max ^b	6 max

^aAs performed on samples prepared in accordance with AASHTO Designation T87.

^bThese values apply to the mineral aggregate prior to mixing with the stabilizing agent.

SOURCE: Adapted with permission from *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, American Association of State Highway and Transportation Officials, Washington, D.C., 2007.

Subgrade strength

To reflect the property of subgrade soils in rigid pavement design procedure, the modulus of subgrade reaction (k) is normally used. This modulus can be estimated by conducting plate bearing test. However, the correlation with other tests is used sometime to estimate this modulus. Figure 2.23 is an example of such correlations.

Current pavement design procedure suggests the use of effective modulus of subgrade reaction. This effective modulus depends on the following factors

1. Seasonal effect on subgrade resilient modulus (as discussed and illustrated in flexible pavement)
2. The type and the thickness of subbase layer being used.
3. The effect of subbase potential erosion.
4. The presence of bedrock layer within the 10 foot below the subgrade surface.

The composite modulus of subgrade reaction can be determined from Figure 2.24. The effective modulus of subgrade reaction is then computed to account for the potential erosion of subbase course. This can be done using Table 2.11 and Figure 2.25.

Furthermore, as mentioned previously, the presence of a bedrock layer within 10 foot below surface of subgrade may affect the subgrade reaction modulus. In fact presence of such rigid foundation may have a positive effect on the overall modulus. Figure 2.26 is used to take such effect into account.

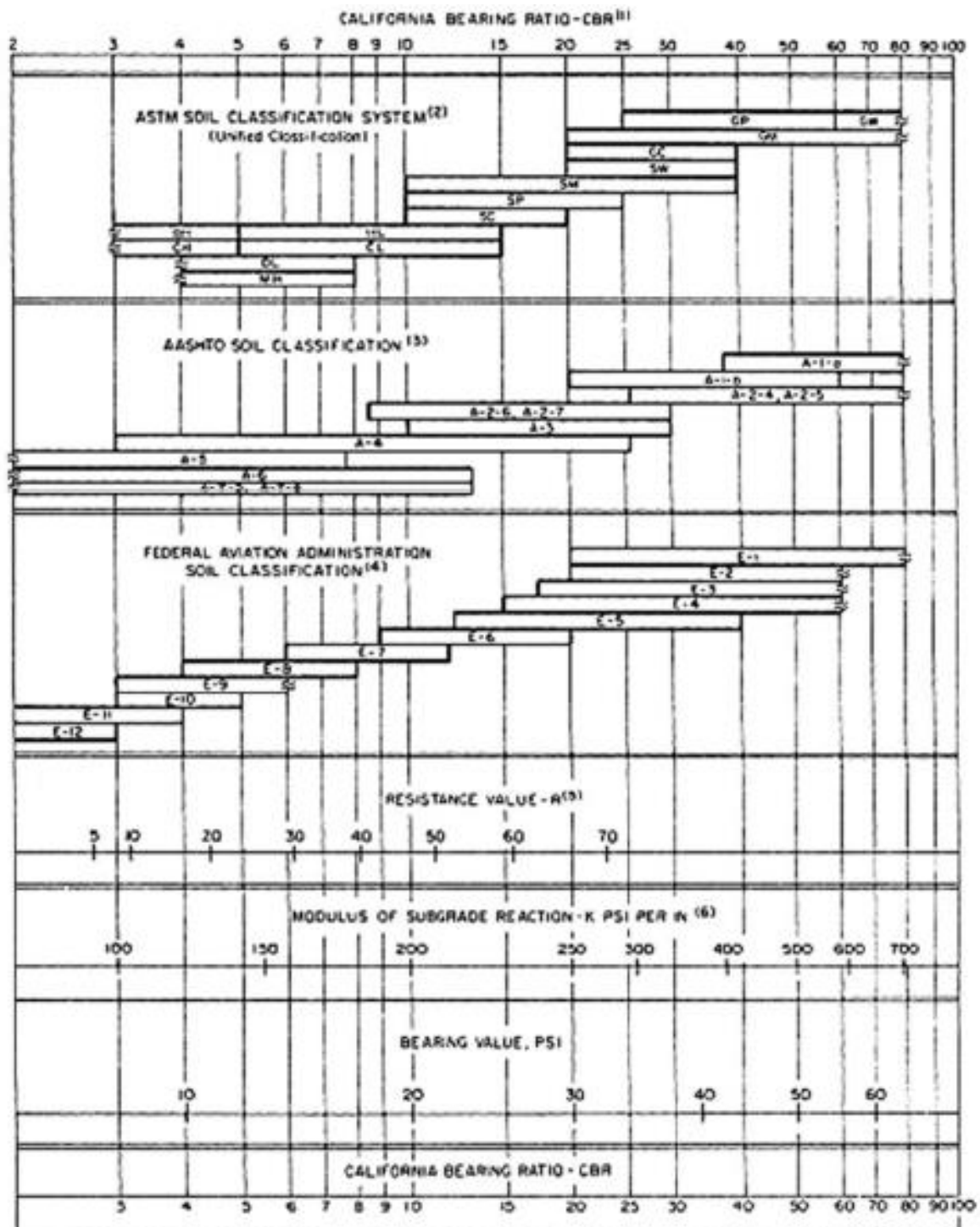
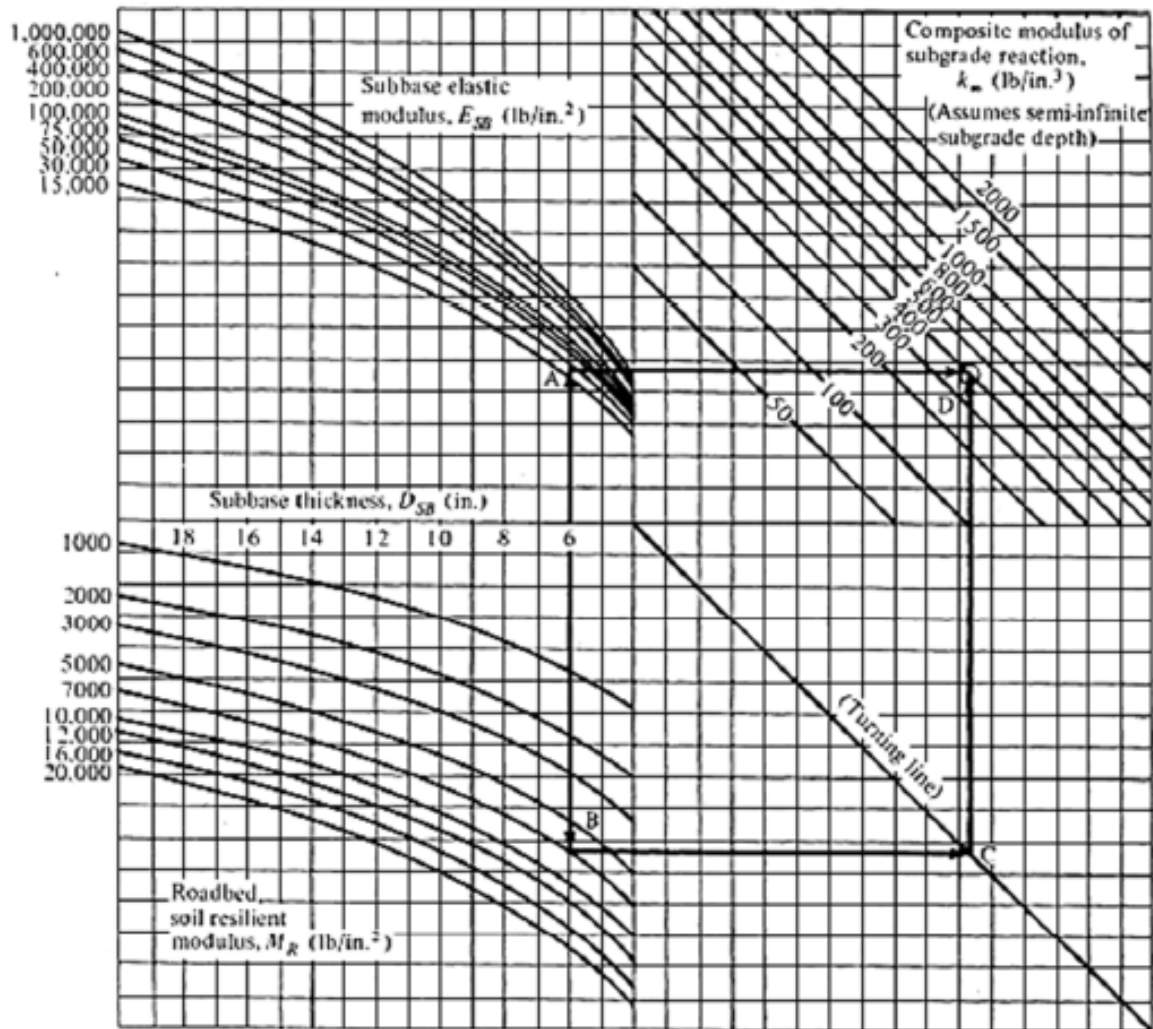


Figure 2.23: Correlation of different soils properties



Example:

$$D_{SB} = 6 \text{ in.}$$

$$E_{SB} = 20,000 \text{ lb/in.}^2$$

$$M_R = 7,000 \text{ lb/in.}^2$$

$$\text{Solution: } k_w = 400 \text{ lb/in.}^3$$

Figure 2.24: Chart for estimation the composite modulus of subgrade reaction

Table 2.11: Loss of support (LS) factors

**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

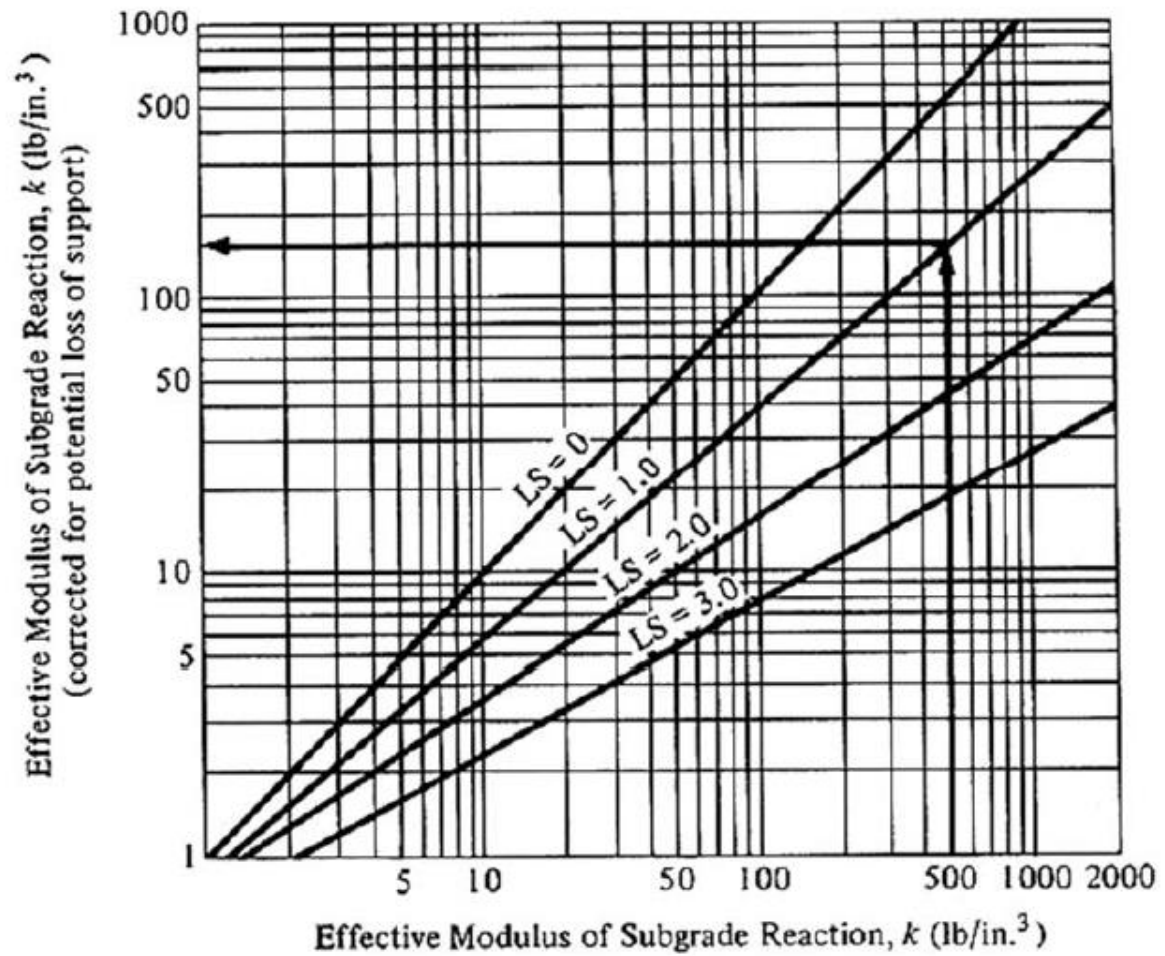


Figure 2.25: Chart for estimation the effective modulus of subgrade reaction corrected for potential loss of support

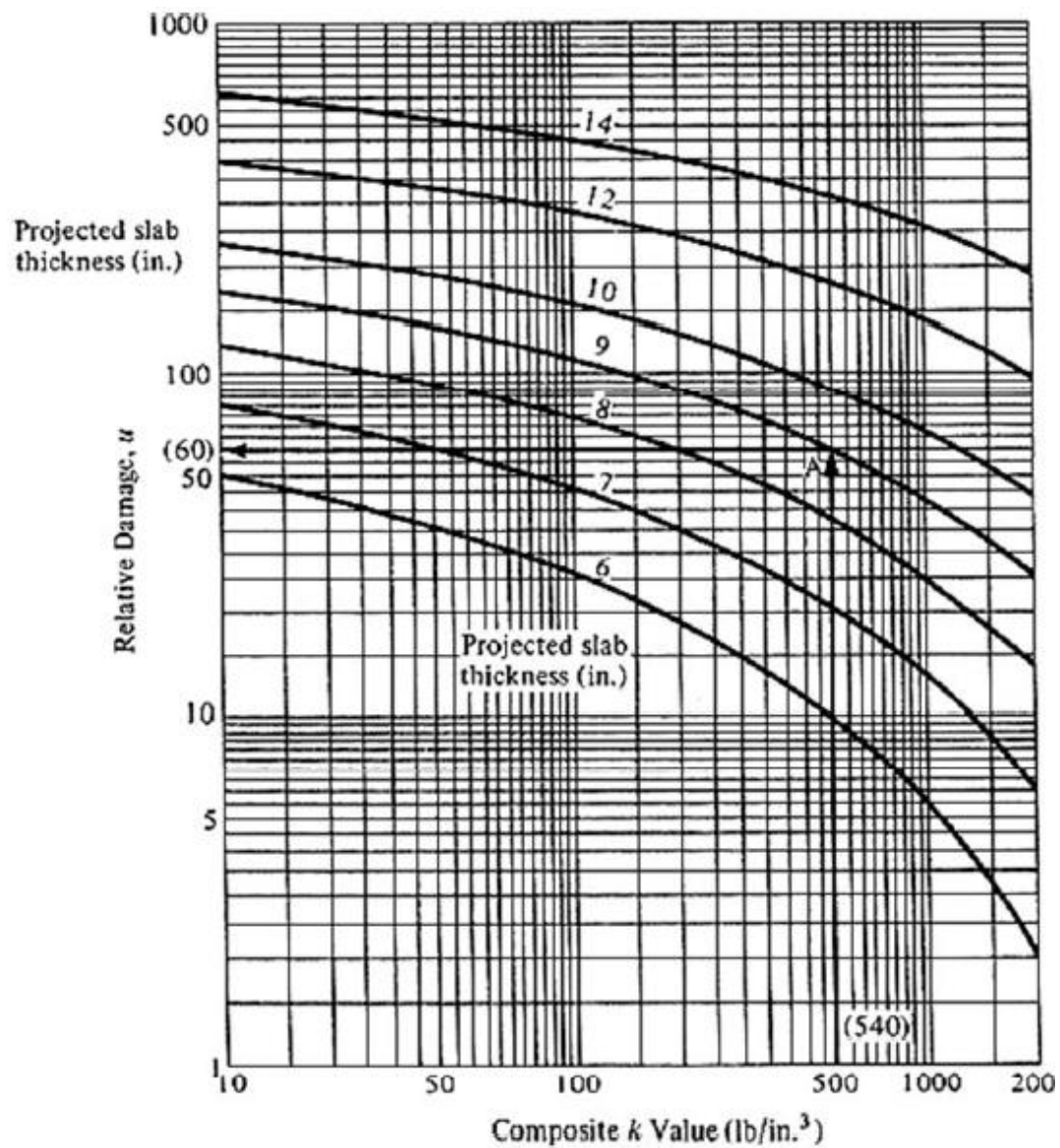


Figure 2.27: relation between composite K value and relative damage