CHAPTER 8
OVERLAY PAVEMENTS

8-1. General.

Normally, overlays of existing pavements are used to increase the load-carrying capacity of an existing pavement, or to correct a defective surface condition on the existing pavement. Of these reasons, the first requires a structural design procedure for determining the thickness of overlay, whereas the second requires only a thickness of overlay sufficient to correct the surface condition, and no increase in load-carrying capacity is considered. The design method for overlays included in this chapter determines the thickness required to increase load-carrying capacity. These methods have been developed from a series of full-scale accelerated traffic tests on various types of overlays and is therefore empirical. These methods determine the required thickness of overlay that, when placed on the existing pavement, will be equivalent in performance to the required design thickness of a new plain concrete pavement placed on subgrade.

8-2. Definitions for Overlay Pavement Design.

The following terms and symbols apply to the design of overlay pavements and are defined for the purpose of clarity.

a. Rigid base pavement. An existing rigid pavement on which an overlay is to be placed.

b. Flexible base pavement. Existing pavement to be overlaid is composed of bituminous concrete, base, and subbase courses.

c. Composite pavement Existing pavement to be overlaid with rigid pavement is composed of an all-bituminous or flexible overlay on a rigid base pavement.

d. Overlay pavement. A pavement constructed on an existing base pavement to increase load-carrying capacity.

e. Rigid overlay. A rigid pavement used to strengthen an existing flexible or rigid pavement.

f. Flexible overlay. A flexible pavement (either all-bituminous or bituminous with base course) used to strengthen an existing rigid or flexible pavement.

8-3. Preparation of Existing Pavement.

Existing pavement is prepared according to procedures in TM 5-822-5/AFM 88-7, Chap. 3.

8-4. Rigid Overlay of Existing Rigid Pavement.

The concrete overlay thickness for roads and streets can be determined using overlay equations 8-1 to 8-3. The conditions for the use of the equations are described in TM 5-822-5/AFM 88-7, Chap. 3.

Fully bonded

$$h_o = h_d - h_E \qquad \text{(eq 8-1)}$$

Partially bonded

$$h_o = \sqrt[1.4]{h_d^{1.4} - C_r \left(\frac{h_d}{h_e} \times h_E\right)^{1.4}} \qquad \text{(eq 8-2)}$$

Nonbonded

$$h_o = \sqrt{h_d^2 - C_r \left(\frac{h_d}{h_e} \times h_E\right)^2} \qquad \text{(eq 8-3)}$$

where

h_o = required thickness of concrete overlay, inches

h_E = thickness of existing concrete slab, or equivalent thickness of plain concrete pavement having the same load-carrying capacity as the existing pavement, inches

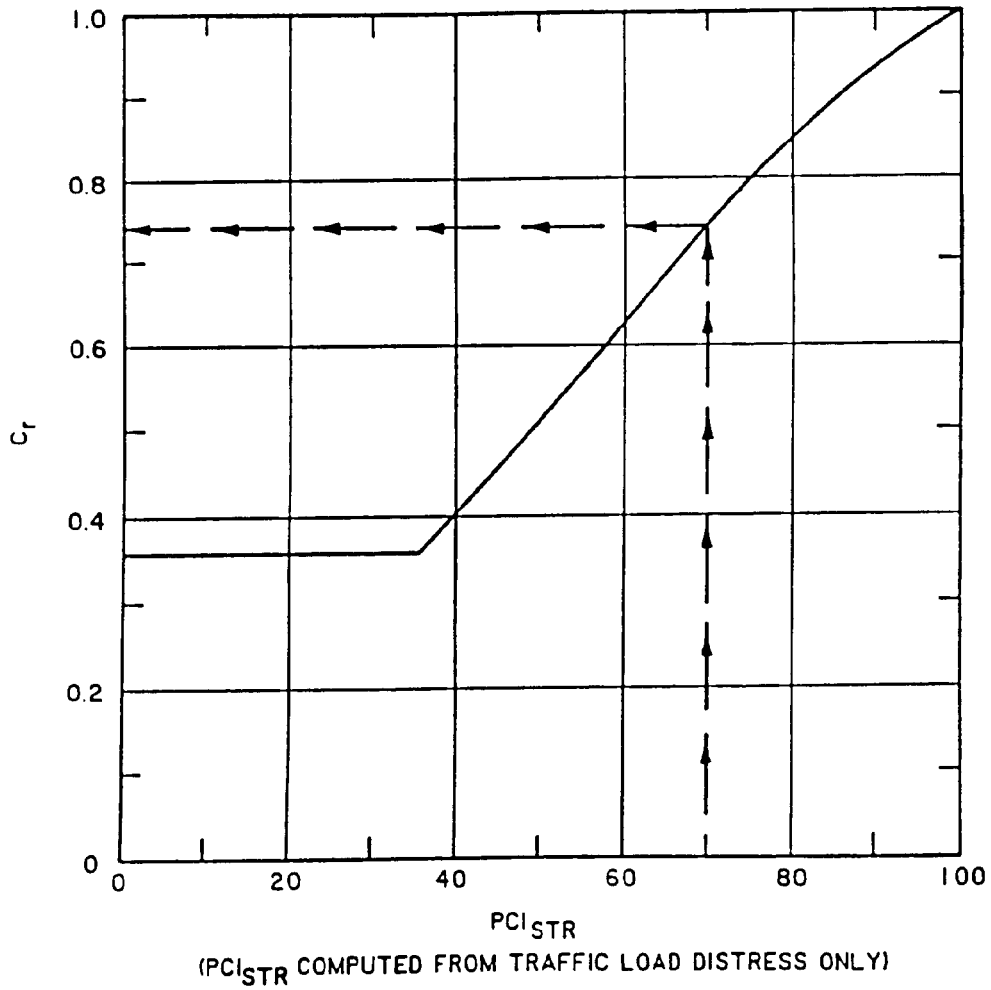

Figure 8-1. Chart for Determining C_r for Concrete Overlays.

h_d = required single slab thickness above existing subgrade determined using the elastic layered method with the design flexural strength of the overlay, inches

h_e = required single slab thickness above existing subgrade determined using the elastic layered method with the measured flexural strength of the existing rigid pavement, inches

C_r = condition factor for plain concrete pavement and reinforced concrete pavement For plain concrete pavement, C_r is assigned according to the following conditions:

C_r = 1.00 — Pavements are in good condition with little or no structural cracking due to load.

C_r = 0.75 — Pavements exhibit initial cracking due to load but no progressive cracking or faulting of joints or cracks.

C_r = 0.35 — Pavements exhibit progressive cracking due to load accompanied by spalling, raveling, or faulting of cracks and joints.

For reinforced concrete pavement, C is assigned according to the following conditions:

C_r = 1.00 — Pavements are in good condition with little or no short-spaced transverse (1- to 2-foot) cracks, no longitudinal cracking, and little spalling or raveling along cracks.

C_r= 0.75 — Pavements exhibit short-spaced transverse cracking but little or no interconnecting longitudinal cracking due to load and only moderate spalling or raveling along cracks.

C_r = 0.35 — Pavements exhibit severe short-spaced transverse cracking and interconnecting longitudinal cracking due to load, severe spalling along cracks, and initial punchout type failures.

An estimate of condition factor C_r may also be made using the structural condition index (SCI) of the existing rigid pavement. The SCI is that part of the pavement condition index (PCI) related to structural distress types or deduct values. The relationship is shown in TM 5-623. If PCI condition survey data are available, C_r can be obtained from figure 8-1 using the structural PCI (PCI computed using only load related distresses).

8-5. Rigid Overlay of Flexible and Composite Base Pavements.

This type of design includes rigid overlay of either flexible or composite base pavements. The design procedure for these types of overlays are contained in TM 5-822-5/AFM 88-7, Chap. 3.

8-6. Flexible Overlay of Rigid Base Pavements.

The flexible overlay thickness for roads and streets can be determined using equation 8-4.

$$t_o = 3.0\ (Fh_d - C_b h_E) \qquad \text{(eq 8-4)}$$

where

t_o = required flexible overlay thickness, inches
F = a factor that projects the cracking expected to occur in the base pavement during the design life of the overlay
h_E, h_d = defined in equation 8-1 to 8-3
C_b = condition factor

Condition factors for existing plain concrete pavements are assigned based on the following conditions:

C_b = 1.00 — Pavements are in good condition with some cracking due to load but little or no progressive-type cracking.
C_b = 0.75 — Pavements exhibit progressive cracking due to load and spalling, raveling, and minor faulting at joints and cracks.
C_b = 0.50 — Pavements exhibit multiple cracking along with raveling, spalling, and faulting at joints and cracks.

Condition factors for existing reinforced concrete pavement are assigned based on the following conditions:

C_b = 1.00 — Pavements are in good condition but exhibit some closely spaced load-induced transverse cracking, initial interconnecting longitudinal cracks, and moderate spalling or raveling of joints and cracks.
C_b = 0.75 — Pavements in trafficked areas exhibit numerous closely spaced load-induced transverse and longitudinal cracks, rather severe spalling or raveling, or initial evidence of punchout failures.

The estimate of condition factor C for plain concrete pavement may be made from the SCI of the existing rigid pavement. The SCI is that part of the PCI related to structural distress types or deduct values. The relationship is shown in TM 5-825-3-1/AFM 88-6, Chap. 3, Section A. However, when determining C_b, the only distresses considered are those associated with structural loading. These include:

a. Longitudinal, transverse, and diagonal cracks of medium to high severity.
b. Corner breaks of any severity.
c. All large patches of load associated failures.
d. Pumping.
e. Settlement or faulting of any severity.
f. Shattered slabs of any severity.
g. Certain types of joint spalls believed to be load-associated.

If the PCI is calculated using only these structural distresses (SCI), C_b can be obtained from figure 8-2.

(1) The F-factor is a function of the foundation k value and design traffic, an is determined as follows.

(2) The modulus of subgrade reaction k may be estimated using the following relationship between subgrade modulus and static modulus of soil reaction or from table 4-2:

$$k = 10^X \qquad \text{(eq 8-5)}$$

where

$$X = \frac{\log_{10} E - 1.415}{1.284}$$

k = modulus of subgrade reaction, pci
E = subgrade modulus, psi

(2) If a base or subbase is present above the subgrade, an effective k is determined from figure 8-3.

(3) The F-factor is then obtained from figure 8-4.

8-7. Flexible Overlay of Flexible Pavements.

The flexible overlay thickness above a flexible pavement is the difference between the existing pavement thickness and a new pavement thickness determined using the layered elastic procedure and the modulus value of the existing subgrade. For instance, if the existing flexible pavement is 16 inches (i.e., 4-inch bituminous concrete, 6-inch base, and 6-inch subbase) and the new pavement thickness is determined by the layered elastic method to be 19 inches, the flexible overlay thickness will be 3 inches.

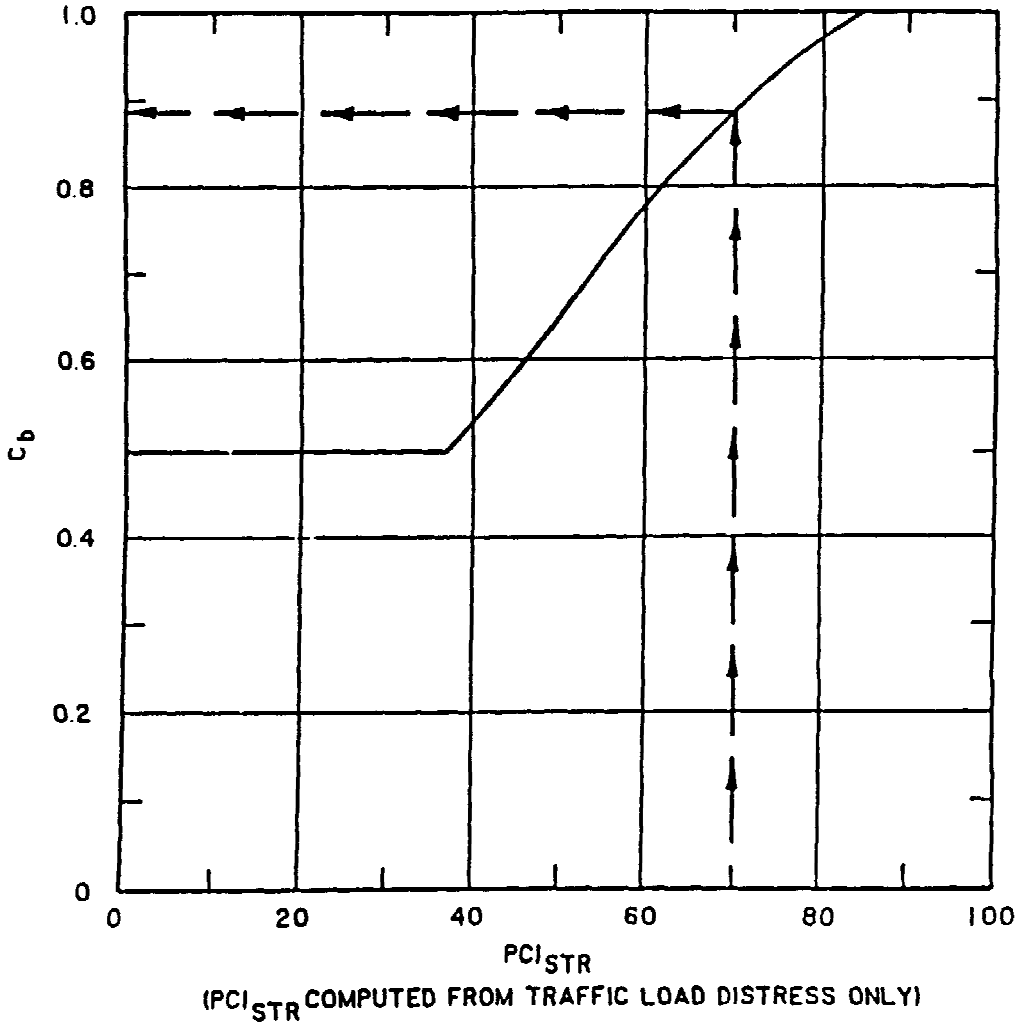

Figure 8-2. Chart for Determining C_b for Flexible Overlays.

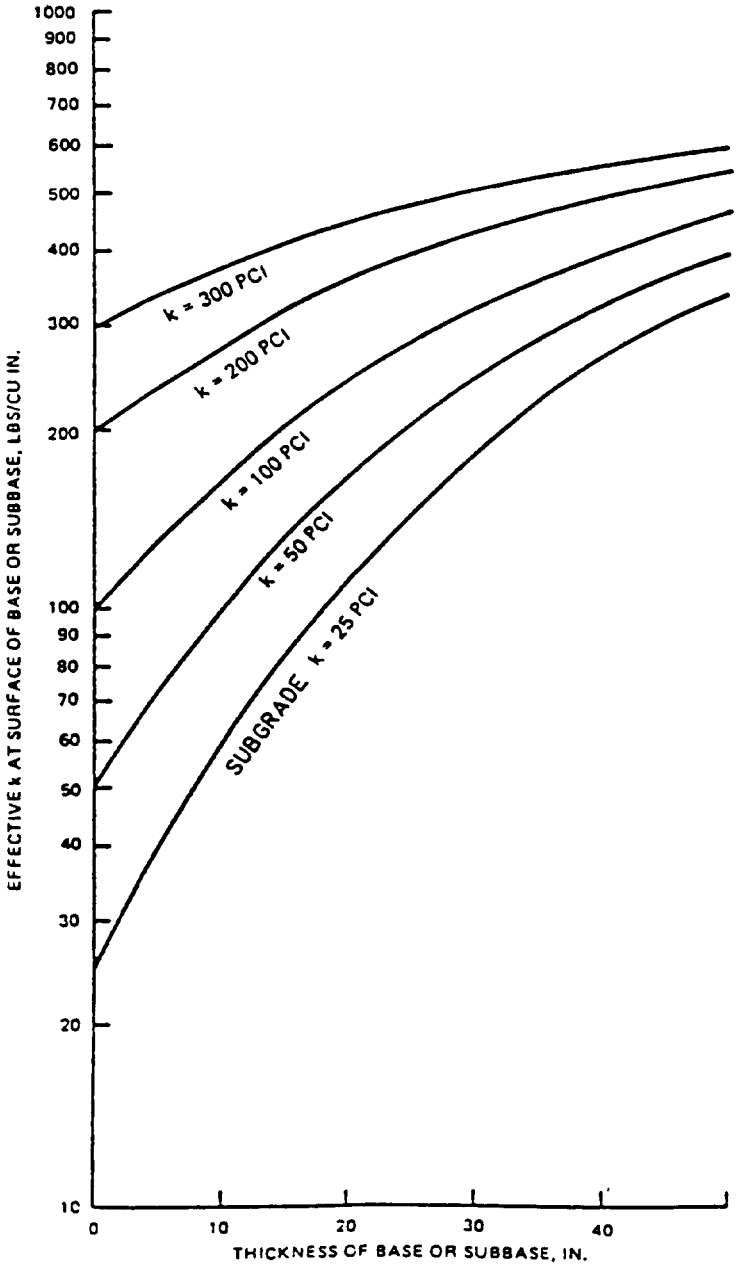

Figure 8-3. Determination of Effective k Value on Top of Base Course.

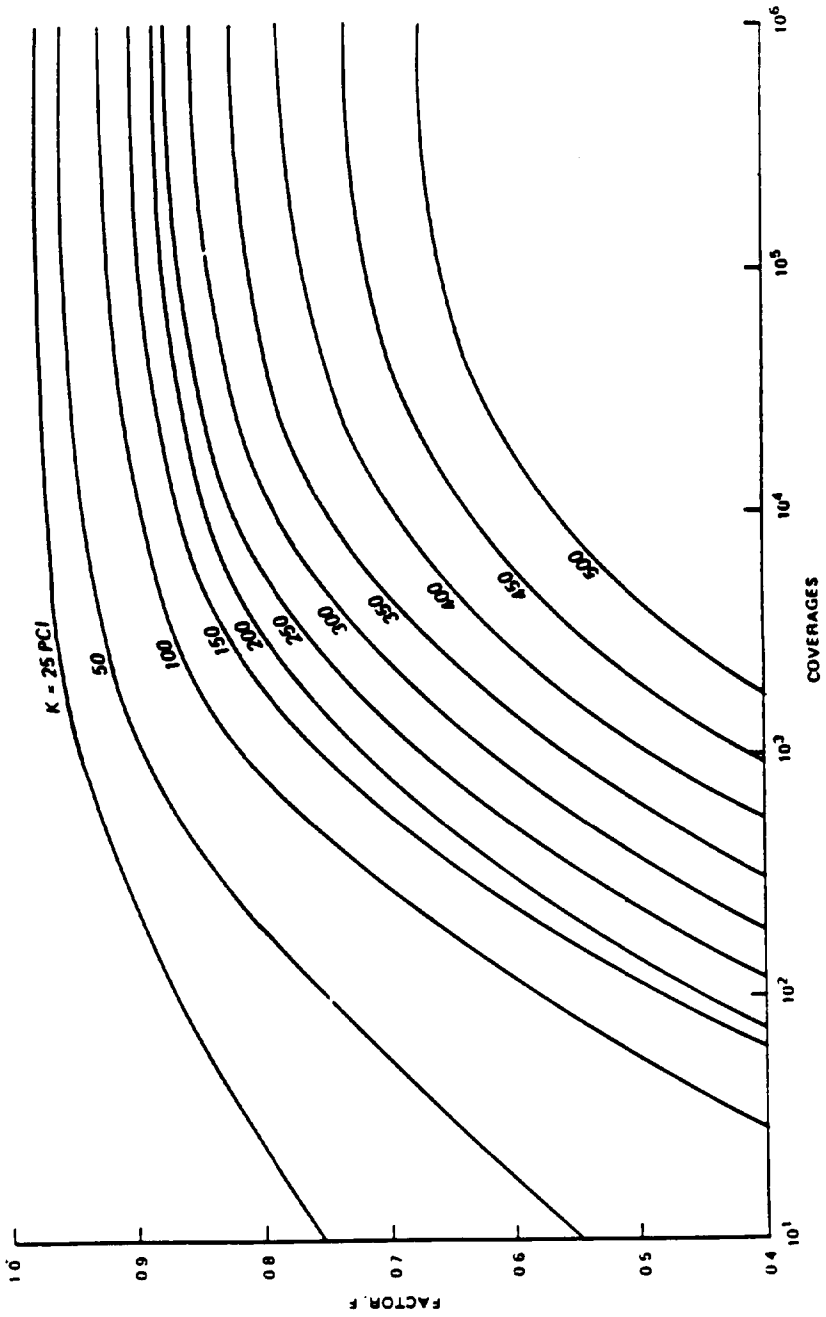

Figure 8-4. Chart for Determining F-Factor for Flexible Overlays.