JOINT DESIGN

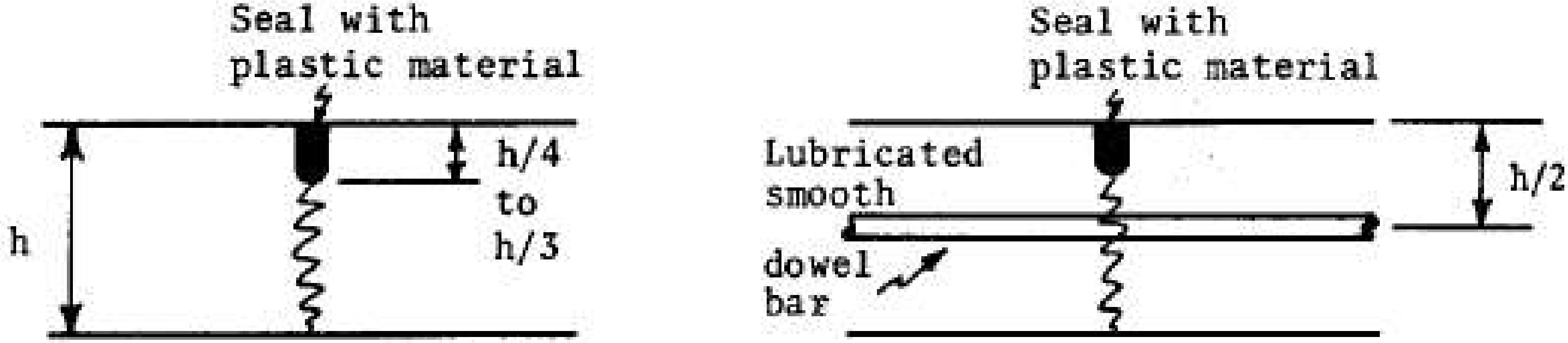
Joint Design

- Joint Types
  - Contraction
  - Expansion
  - Construction
  - Longitudinal
- Joint Geometry
  - Spacing
  - Layout (e.g., regular, skewed, randomized)
  - Dimensions
- Joint Sealant Dimensions

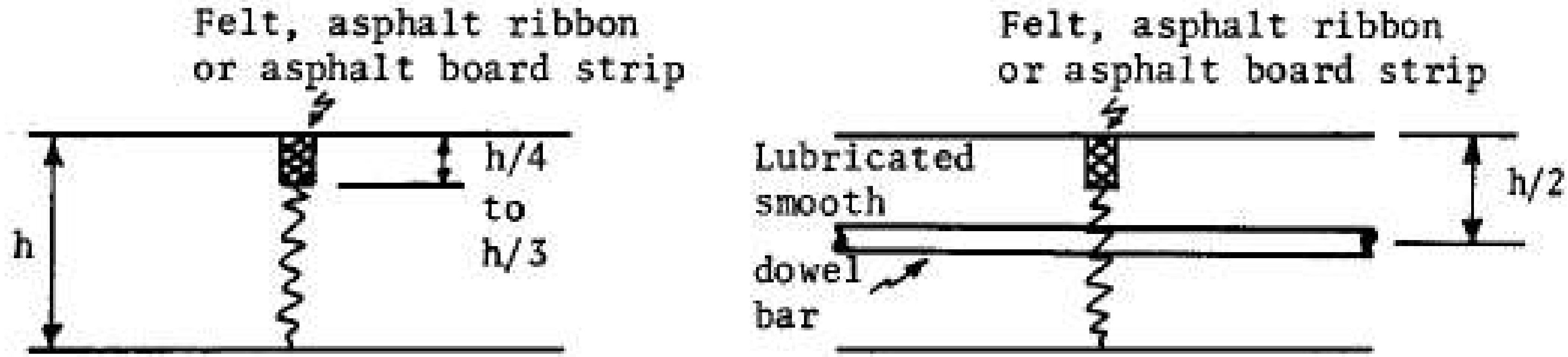
Types of Joints

- Contraction
  - Transverse
  - For relief of tensile stresses
- Expansion
  - Transverse
  - For relief of compressive stresses
  - Used primarily between pavement and structures (e.g., bridge)
- Construction
- Longitudinal
  - For relief of curling and warping stresses

Typical Contraction Joint Details



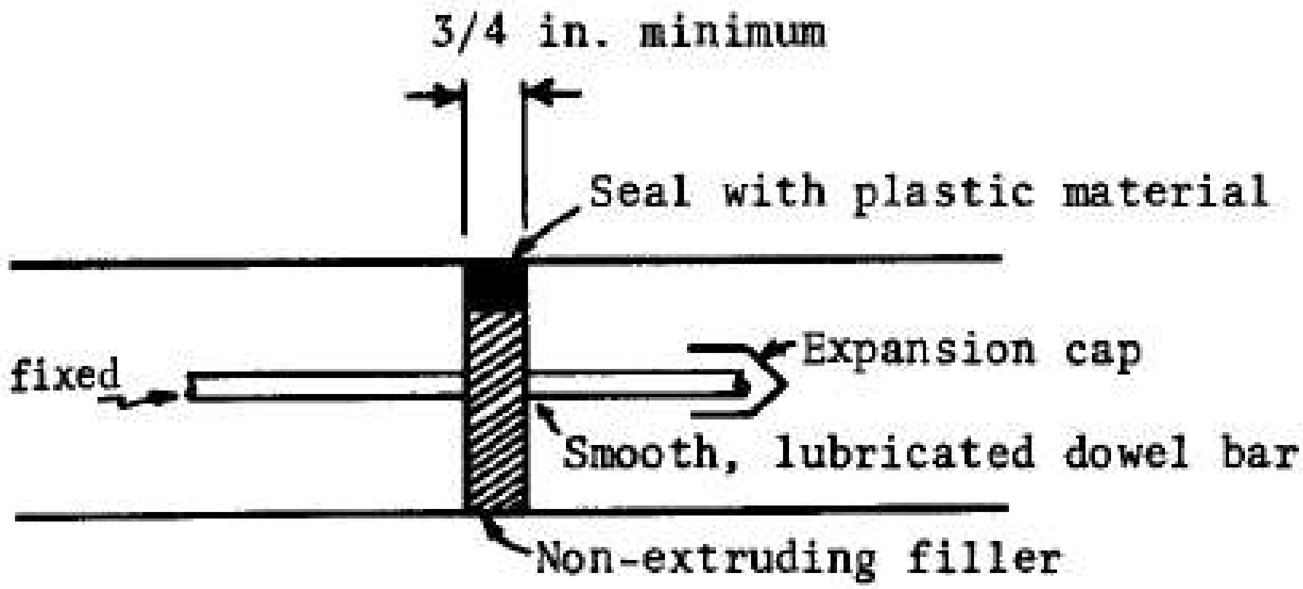
(a) Dummy Groove



(b) Premolded Strip

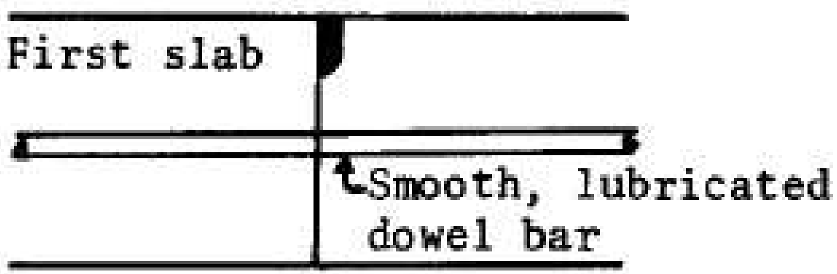
(Huang, 1993)

Typical Expansion Joint Detail

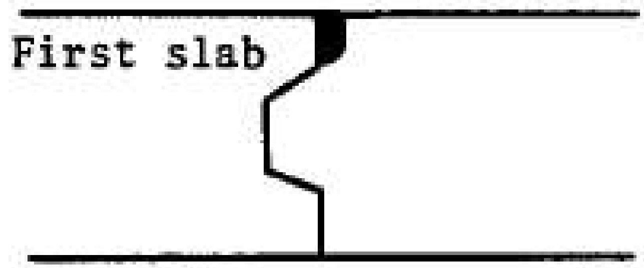


(Huang, 1993)

Typical Construction Joint Detail



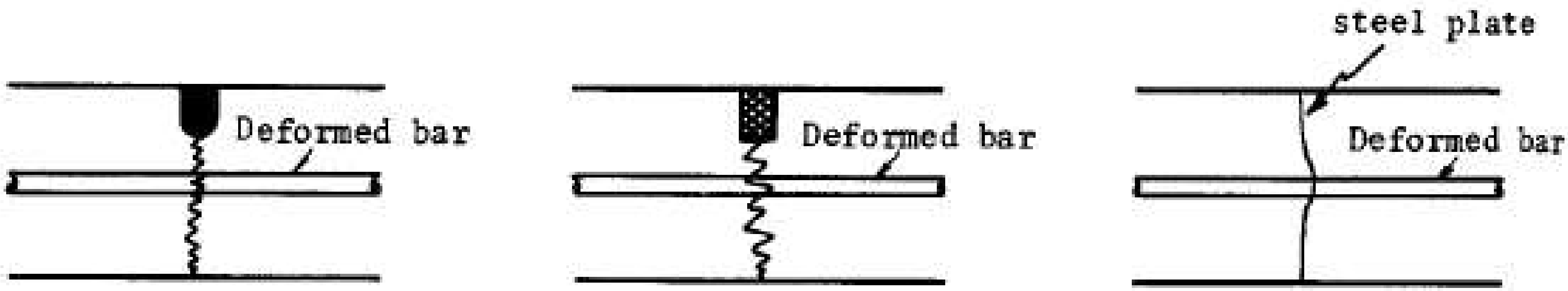
(a) Butt Joint at Contraction Joint.



(b) Key Joint for Emergency.

(Huang, 1993)

Typical Longitudinal Joint Detail



(a) Dummy Groove.

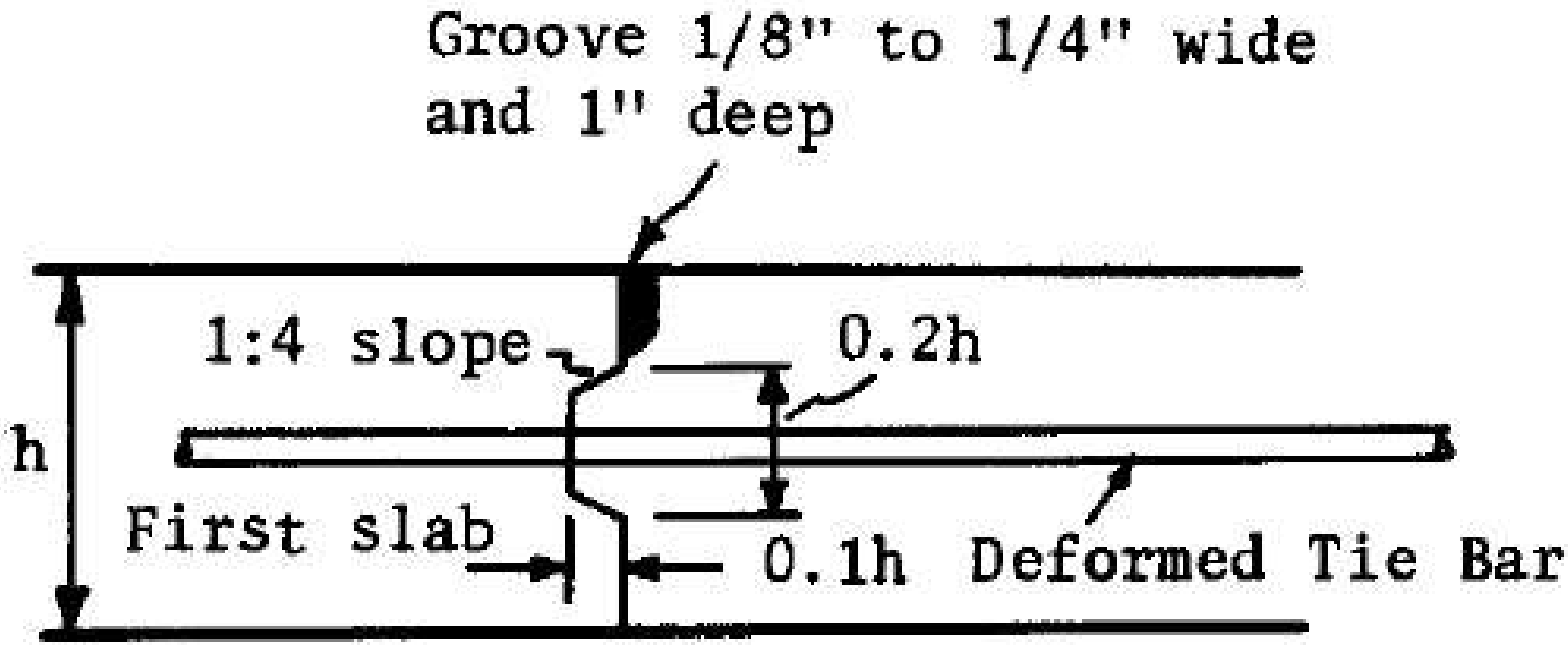
(b) Ribbon or Premolded Strip.

(c) Deformed Plate.

Full Width Construction

(Huang, 1993)

Typical Longitudinal Joint Detail



Lane-at-a-Time Construction

(Huang, 1993)

Joint Spacing

- Local experience is best guide
- Rules of thumb:
  - JCP joint spacing (feet) $\leq$ 2D (inches)
  - W/L $\leq$ 1.25

Joint Dimensions

- Width controlled by joint sealant extension
- Depths:
  - Contraction joints: D/4
  - Longitudinal joints: D/3
- Joints may be formed by:
  - Sawing
  - Inserts
  - Forming

Joint Sealant Dimension

Governed by expected joint movement, sealant resilience

$$\Delta L = \frac{CL(\alpha_c \times DT_D + Z)}{S} \times 100$$

where

ΔL = the joint opening caused by temperature changes and drying shrinkage of the PCC, in.,

S = allowable strain of joint sealant material. Most current sealants are designed to withstand strains of 25 to 35 percent, thus 25 percent may be used as a conservative value,

α_c = the thermal coefficient of contraction of portland cement concrete, °F,

Z = the drying shrinkage coefficient of the PCC slab, which can be neglected for a resealing project, in./in.,

L = joint spacing, in.,

DT_D = the temperature range, °F, and

C = the adjustment factor due to subbase/slab friction restraint. Use 0.65 for stabilized subbase, 0.80 for granular base.

(AASHTO, 1993)

Design Inputs

Z

Table 2.9. Approximate Relationship Between Shrinkage and Indirect Tensile Strength of Portland Cement Concrete (6)

Indirect Tensile Strength (psi)	Shrinkage (in./in.)
300 (or less)	0.0008
400	0.0006
500	0.00045
600	0.0003
700 (or greater)	0.0002

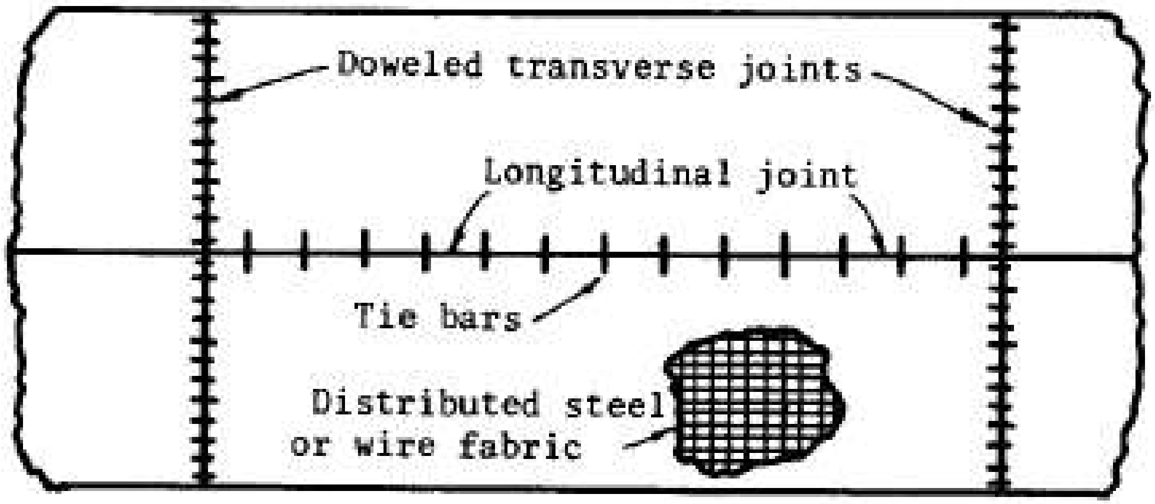
α_c

Table 2.10. Recommended Value of the Thermal Coefficient of PCC as a Function of Aggregate Types (8)

Type of Coarse Aggregate	Concrete Thermal Coefficient (10^{-6}/°F)
Quartz	6.6
Sandstone	6.5
Gravel	6.0
Granite	5.3
Basalt	4.8
Limestone	3.8

(AASHTO, 1993)

Reinforcement Design (JRCP)

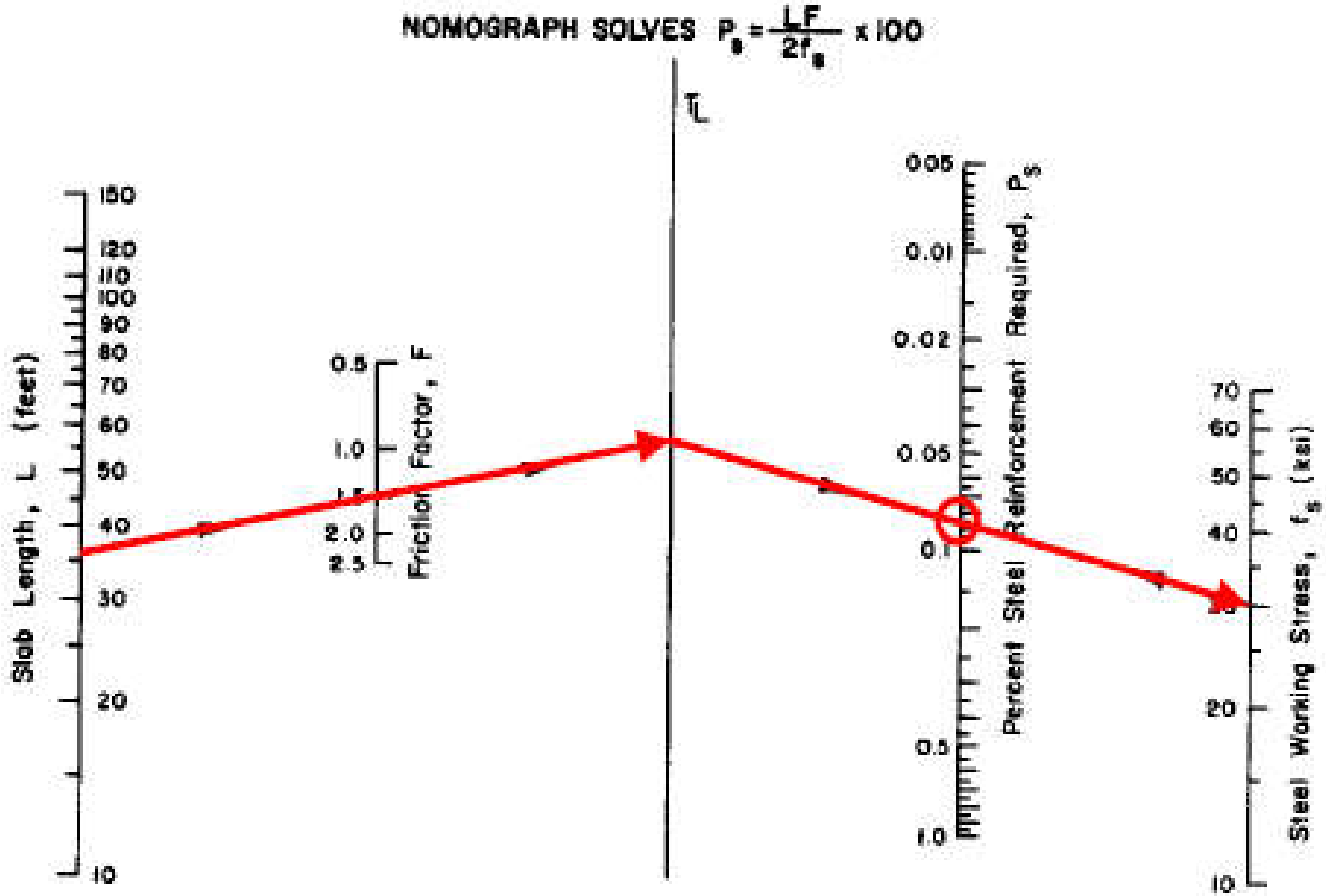


- Purpose of reinforcement is not to prevent cracking, but to hold tightly closed any cracks that may form
- Physical mechanisms:
  - Thermal/moisture contraction
  - Friction resistance from underlying material
- Design based on friction stress analysis

(Huang, 1993)

Dowel Bars: Transverse Joint Load Transfer

- "…size and spacing should be determined by the local agency's procedures and/or experience."
- Guidelines:
  - Dowel bar diameter = D/8 (inches)
  - Dowel spacing: 12 inches
  - Dowel length: 18 inches



Example:
L = 36 ft.
F = 1.5
f_s = 30,000 psi

Solution:
P_s = .085%

Applies to both longitudinal and transverse steel reinforcement

(Generally, P_s=0 for L< ~15 feet)

(AASHTO, 1993) **Figure 3.8. Reinforcement Design Chart for Jointed Reinforced Concrete Pavements**

Friction Factor

Table 2.8. Recommended Friction Factors (*7*)

Type of Material Beneath Slab	Friction Factor (F)
Surface treatment	2.2
Lime stabilization	1.8
Asphalt stabilization	1.8
Cement stabilization	1.8
River gravel	1.5
Crushed stone	1.5
Sandstone	1.2
Natural subgrade	0.9

(AASHTO, 1993)

Steel Working Stress

Table 3.7. Allowable Steel Working Stress, ksi (*10*)

Indirect Tensile Strength of Concrete at 28 days, psi	Reinforcing Bar Size*		
	No. 4	No. 5	No. 6
300 (or less)	65	57	54
400	67	60	55
500	67	61	56
600	67	63	58
700	67	65	59
800 (or greater)	67	67	60

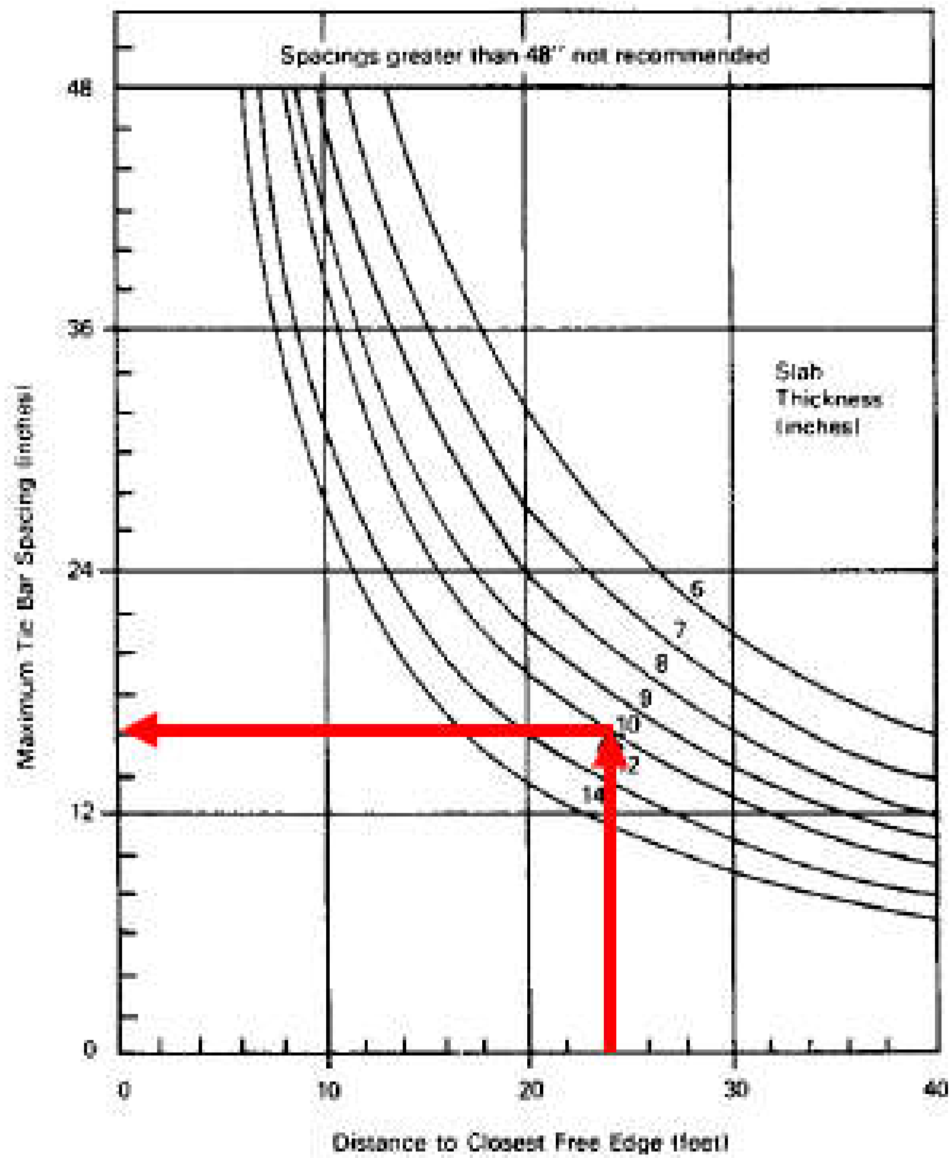
*For DWF proportional adjustments may be made using the wire diameter to bar diameter.

∴ DWF stands for Distributed Wire Fabric

Based on preventing fracture and limiting permanent deformation.

(AASHTO, 1993)

Transverse Tie Bars



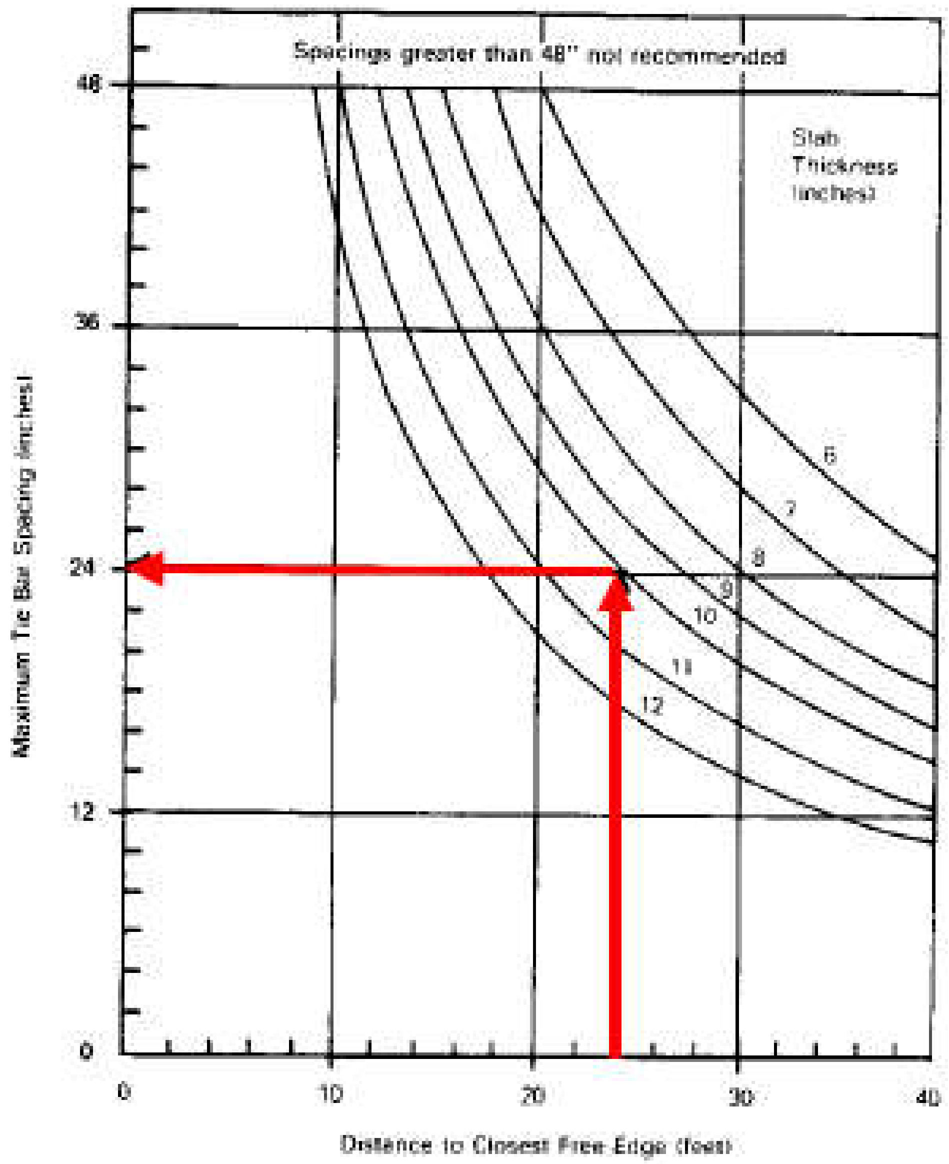
Example: Distance from free edge = 24 ft.
D = 10 in.

Answer: Spacing = 16 in.

(AASHTO, 1993)

Figure 3.13. Recommended Maximum Tie Bar Spacings for PCC Pavements Assuming ½-inch Diameter Tie Bars, Grade 40 Steel, and Subgrade Friction Factor of 1.5

Transverse Tie Bars



Example: Distance from free edge 24 ft.
D 10 in.

Answer: Spacing 24 in.

(AASHTO, 1993)

Figure 3.14. Recommended Maximum Tie Bar Spacings for PCC Pavements Assuming ⁵/₈-inch Diameter Tie Bars, Grade 40 Steel, and Subgrade Friction of 1.5

SEALING JOINTS

Before sealing, the joint is required to be clean of all foreign materials. This is done by water blasting, sand blasting, mechanical wire brushing, or a combination thereof. Care is taken not to damage the joint when cleaning. All residue of the sawing operation is required to be removed from the joint face for proper sealant adhesion. A quick test for cleanliness may be made by inserting a small clean object into the joint. If residue or dust is retained on the object, additional cleaning is required. Once the joint has been thoroughly cleaned, the backer rod may be installed, if required, and the sealer may be placed.

All joints are to be sealed prior to discontinuing work for the construction season or before opening the pavement to public traffic. Construction traffic may be allowed upon the pavement prior to this sealing process.