Designing Floor Slabs On Grade

Step-by-Step Procedures, Sample Solutions, and Commentary

Second Edition

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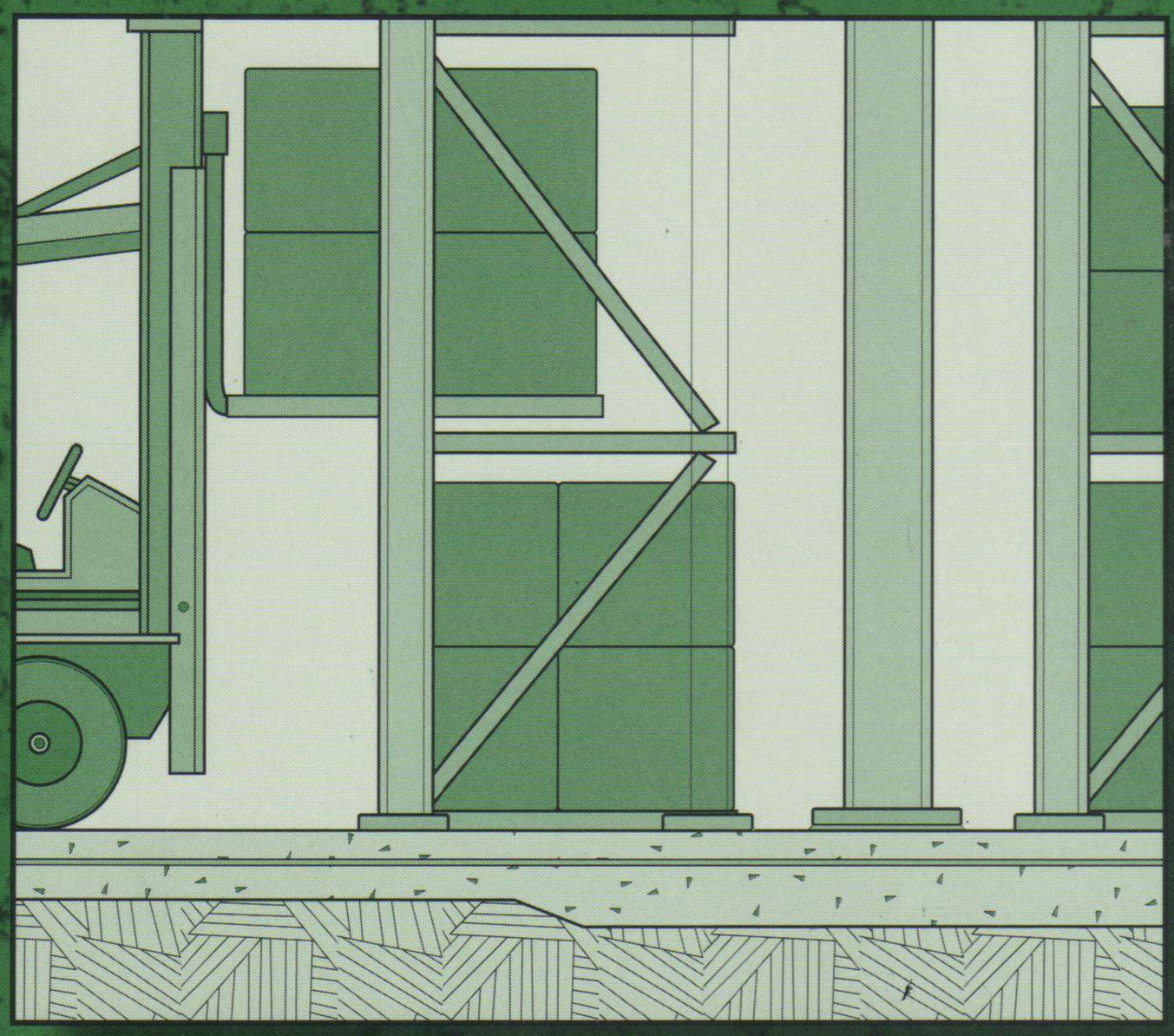

The coefficient of thermal expansion is normally taken as 6.5 × 10^{-6} in/in/°F. A common thermal gradient for this procedure is 50° in controlled environments and more in uncontrolled environments. The modulus of elasticity for steel is normally taken as 29 × 10^6 psi.

Commentary:
An even better procedure for crack control is to equate the shrinkage potential of the concrete to a needed force in the reinforcing. This results in $P = \delta A E_c$ *where* δ *is the unit shrinkage of the concrete,* A *is the unit concrete cross sectional area, and* E_c *is the modulus of elasticity for the concrete. Excessive panel lengths are still discouraged. This amount of steel (1.3%) is often considered too costly.*

1.5.1.5—Equivalent strength method

An alternative procedure for selecting the area of steel for slabs on grade is the equivalent strength procedure. This procedure equates the cross sectional area of concrete multiplied by the working stress to an equal amount of reinforcing steel force. The formula is:

$$A_s = \frac{36\sqrt{f_c'}\ t}{f_s}$$

where A_s = cross-sectional area of steel in square inches per lineal foot of slab width
t = slab thickness, inches
f_c' = compressive strength of the concrete, psi
f_s = allowable steel stress, psi

The above formula assumes the rupture modulus of concrete at 7.5 $\sqrt{f_c'}$, with a working stress of 0.4 × *MOR*.

Neither the temperature method (Section 1.5.1.4) nor the equivalent strength method for selecting steel area negates the requirement for ample contraction joints. Concrete is going to shrink and therefore it will crack. The designer's responsibility is to provide a degree of crack control that is compatible with the owner's use and budget constraints.

1.5.1.6—Slab with structurally active steel

Since the reinforcing steel absolutely must be in its detailed location, bolster (bar) supports are recommended.

The conventional design of an industrial floor intentionally selects a slab thickness with the intent that the floor will remain uncracked due to superimposed loadings on the slab's surface. A slab with structurally active steel is one with sufficient areas of steel to produce more moment capacity than that of the unreinforced, uncracked concrete slab. The steel requirements depend upon the amount of moment capacity required by the loadings *(Reference 11)*.

The behavior of the slab designed with structurally active steel reinforcement is similar to but not equal to that of the conventionally designed slab. It may be expected to remain uncracked up to the loading that produces a moment which exceeds the concrete's cracking moment capacity. At that point, the steel becomes structurally active and added moment capacity, and thus additional load support capability, exists. The added strength depends on the percentage of distributed steel, whether one or two layers are used, and the location(s).

Simply defined, a slab on grade is structurally reinforced (structurally active) when the moment capacity of the reinforced slab exceeds the cracking moment of the unreinforced slab.

1.5.1.7—Steel types and designations

The authors' choice as the most straightforward procedure for selecting steel requirements is to express the needed area in terms of either Grade 40 or Grade 60 deformed bars. From this initial selection, adjustments can be made for modified areas of welded wire fabric. Since welded wire fabric frequently achieves yield strengths as high as 75 to 80 ksi, in contrast to the 40 or 60 ksi yield strength specified for reinforcing bars, a lower cross-sectional area than that selected for reinforcing bars may be acceptable when using welded wire fabric. The designer may wish to designate a performance specification for welded wire fabric substitutions for a conventional rebar design rather than risk the exclusion of potential wire fabric suppliers. An important factor