

## 4.2 — Information needed to solve the post load problem

To solve for the required design details, it is necessary to have accurate information about the pattern of the racks and their anticipated loadings. The usual design problem is to find the required slab thickness. Occasionally, the slab thickness is set and either the permissible loading or the required size of the post's base plate is needed. For any of these, the following values are needed:

### Commentary:

*This post load may be based on either the anticipated weight (psf) for each shelf, or the maximum possible load based on the post's or shelves' structural capacity.*

### From the loading specifications:

Post spacing  $X$  (inches), which is the short distance between posts  
 Post spacing  $Y$  (inches), which is the long distance between posts  
 Post spacing  $Z$  (inches), which is the end spacing between rack units  
 All of these spacings are center to center of post.  
 Base plate size (effective contact area), in square inches  
 Post load,  $P$ , pounds or kips

### From the material, the site, and the designer:

Compressive strength of concrete,  $f'_c$ , in psi  
 Modulus of rupture of concrete,  $MOR$ , in psi  
 Subgrade modulus,  $k$ , in pci  
 Safety factor,  $SF$  (unitless)

*It is straightforward and reasonable to interpolate between chart values or to solve the problem with a  $k$  value above and below that which exists, and then use a weighted average for the solution. It is very difficult to accurately extrapolate (work outside the boundary values) from the charts and this extrapolation is not recommended.*

*It is common to store materials directly on the floor beneath the shelves. The material on the floor does not add to the post loading and usually does not increase the positive moment beneath the post. On the other hand, it does add to the uniform loading when the negative moment in the aisle is being checked, as in the example in Chapter 6.*

## 4.3 — Using PCA charts to design for rack storage post loading: AUTHORS' CHOICE

The PCA charts used for the solution of this problem come from *References 6 and 14*. Larger copies of these charts for use by the designer appear in the appendix section. At this book's publication, the only charts available were for subgrade modulus  $k$  values of 50, 100, and 200 pci.

For the first example, a common arrangement of racks and posts will be used as follows:

### From materials, site, and designer:

Concrete compressive strength:  $f'_c = 3000$  psi  
 Modulus of Rupture:  $MOR = 493$  psi  
 Subgrade Modulus:  $k = 100$  pci  
 Safety Factor:  $SF = 1.7$

### From loading specifications:

Short post spacing:  $X = 48$  inches (4 feet)  
 Long post spacing:  $Y = 96$  inches (8 feet)  
 Spacing between rack units:  $Z = 16$  inches  
 Base plate area: 20 square inches (4 x 5 inches)  
 Five shelves at 100 psf per shelf  
 Post load:  $P = 100 \times 4 \times 8 \times 5$

$= 16,000$  pounds or 16 kips

*Full load on one post??*

The required slab thickness is selected from *Figure 29* in the following manner:

- First calculate the allowable stress per 1000 pounds (1 kip) of post load. All post loads are equal. Allowable stress = modulus of rupture divided by the factor of safety, or  $493/1.7 = 290$  psi. Since each post load is 16 kips, the allowable stress per 1000 pounds of post load is  $290/16 = 18.1$  psi per kip.



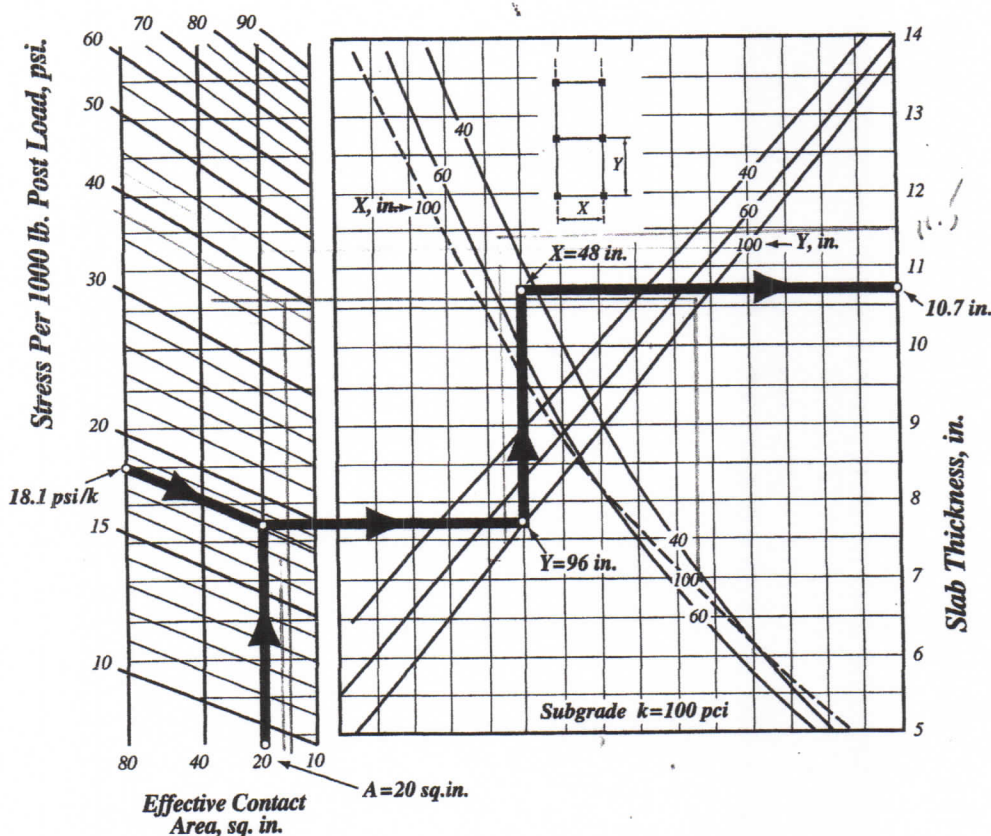


Figure 29 PCA chart for slab thickness selection when using post loading with subgrade  $k = 100$  pci.

- Enter the Figure 29 chart at the base plate area of 20 square inches and move vertically up to the slanted line at 18.1 psi per kip.
- Draw a straight line to the right to the line representing  $Y = 96$  inches. **The chart must be used by going to the Y-line first and then to the X-line.** The reverse is incorrect.
- Draw a line vertically to the curved line representing  $X = 48$  inches, as close as is graphically possible.
- Finally, draw a horizontal line to the right where it intersects the vertical axis representing thickness. For this example, the intersection is at a thickness of 10.7 inches.
- A slab thickness of 11 inches is recommended.
- When this example is solved by other procedures, the required thickness is 10.4 inches using the AIRPORT program and 10.6 inches using the MATS program.

#### Commentary:

For the same problem, if the base plate were increased to 64 square inches (8x8 inches), the slab thickness indicated by the chart would be very close to 9.4 inches. On the other hand, if the same problem (base plate 4x5 inches) were checked using a shelf load of 50 psf (instead of 100 psf), the required slab thickness would be very close to 6.9 inches.

## 4.4 — Using PCA charts when actual $k$ does not equal chart $k$ : AUTHORS' CHOICE

Since charts exist for only three specific  $k$  values (Reference 14), here is a rational procedure which can be used when a field value of  $k$  exists for which no rack load chart is available. This could be the case for a  $k$  of 300 pci or a  $k$  of 150 pci, as examples. These are handled in two different ways depending on whether the field  $k$  is between chart  $k$  values or outside of them (higher or lower).

#### When $k$ is between values for which the charts were developed:

Interpolation or averaging can be used. The authors suggest determining the required thickness for the chart  $k$  value immediately below the actual field value and then repeating that for the chart  $k$  value immediately above the field value. Then, average the two

The PCA documents are the only known source of design charts for patterned post loadings.