Analysis and Design of Slabs on Grade with Single Layer of Reinforcement

Ground supported slabs are frequently designed with a single layer of reinforcing. Such slabs are referred to as membrane slabs, floating slabs, or filler slabs and range in thickness from as little as 4" to 8" depending on the supported loads. In warehouses and storage facilities such slabs are subjected to concentrated point loads from storage rack posts or forklift wheel loads.

Example Model with Sample Input

In this example, a concrete warehouse floor with joints spacing 20' o.c. a slab is subject to modular racking posts loads of 5,500 lbs each in a grid of 6' × 6'. The 6" slab is supported on soil with a subgrade modulus of 100 kcf.

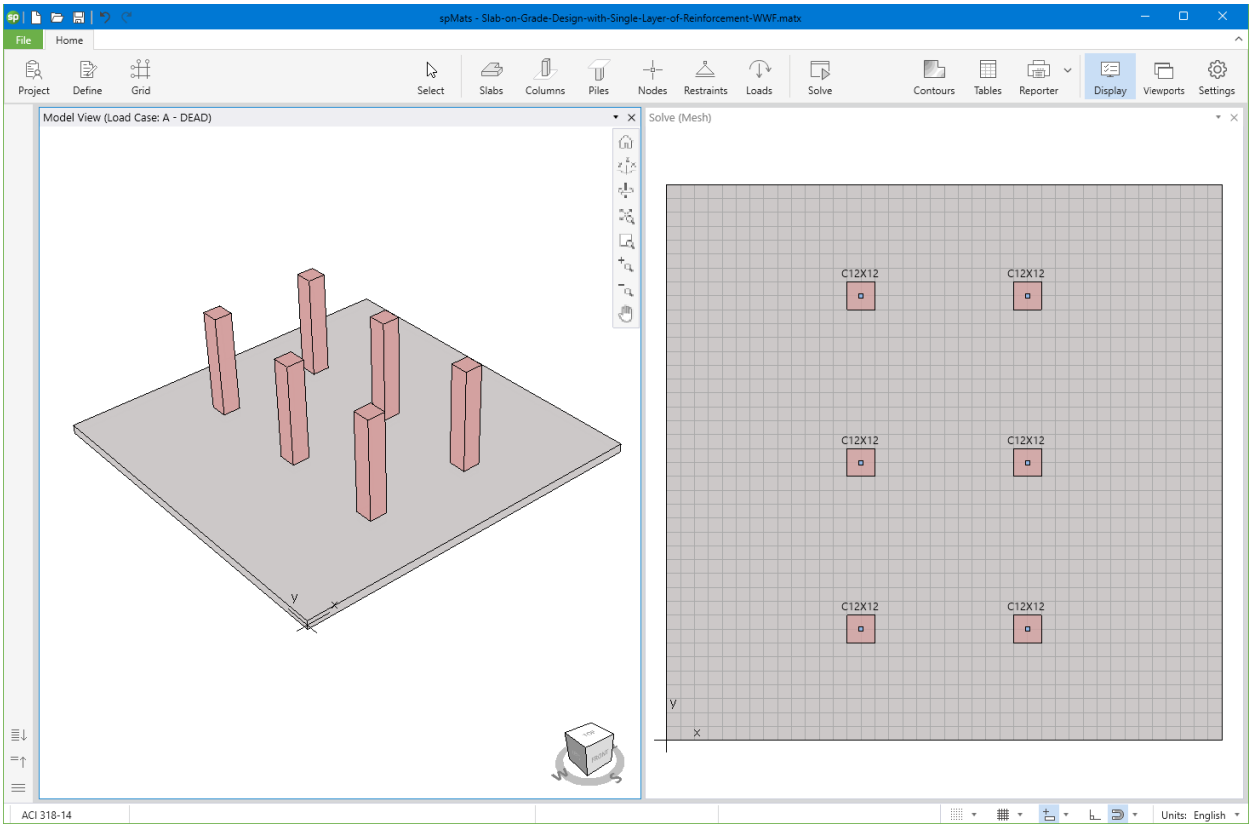


Figure 1 – 3D View and Plan View

To investigate or design a slab with a single layer of reinforcement, spMats design parameters definition input requires special attention in order to determine the correct area of steel required.

Design Parameters Input

To model a single layer of reinforcing, cover distance for top and bottom reinforcement should be input such that they are at the same plane per each of the x and y directions. The reinforcement location is measured to the centerline of reinforcement. For a 6 in. thick slab on grade and assuming No. 4 bars with 2 in. clear cover at the top, the reinforcement location for single layer reinforcement is entered for top layer and bottom layer such that both are at the same horizontal plane. (i.e. 2.25 in. from top of the slab and 3.75 in. from bottom of the slab for a 6 in. thick slab)

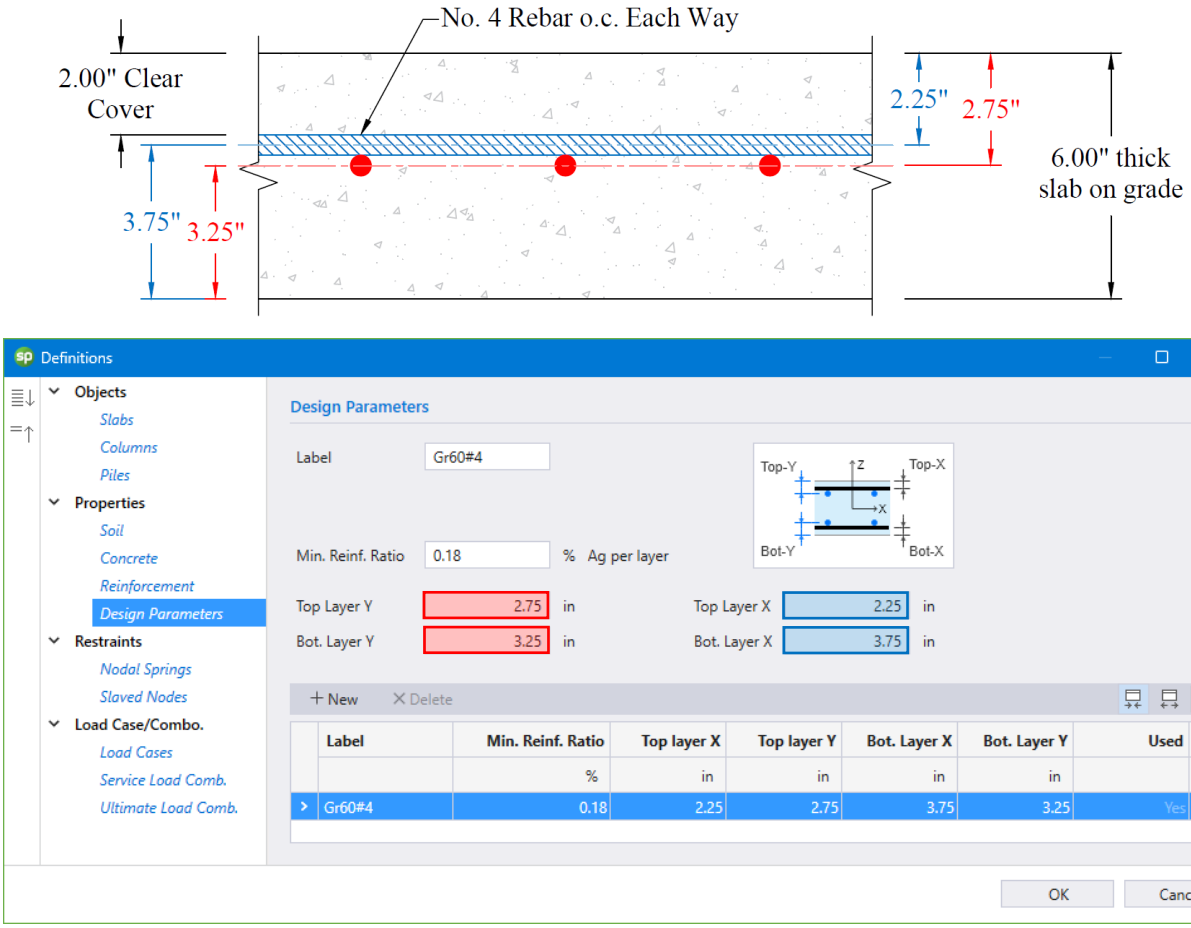


Figure 2 – Design Parameters Input

The reinforcement location input should be adjusted depending on bar sizes. For example, if No. 6 bars are to be utilized, reinforcement locations will be as follows:

Top Layer – X-Dir. = 2.00 + 0.75/2 = 2.375 in.

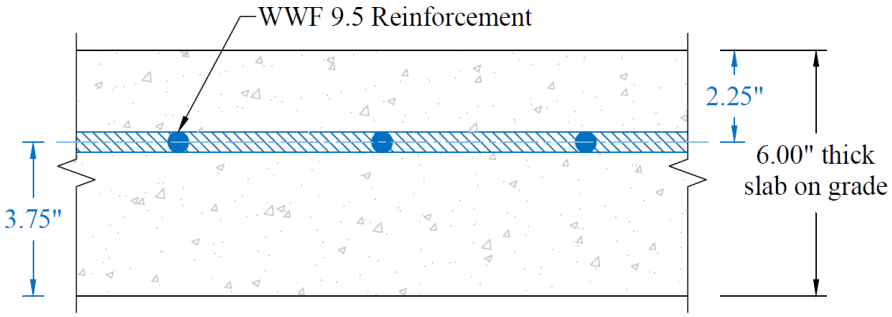
Top Layer – Y-Dir. = 2.375 + 0.75 = 3.125 in

Bottom Layer – X-Dir. = 6.00 + 2.375 = 3.625 in.

Bottom Layer – X-Dir. = 6.00 + 3.125 = 2.875 in.

The top reinforcement layer input is used by the Program to calculate the reinforcement area required per unit length to resist tension at the top of the slab. Similarly, the bottom reinforcement layer input is used by the Program to calculate the reinforcement area required per unit length to resist tension at the bottom of the slab. Since both of these layers are in the same horizontal plane, the envelope value of the top and bottom reinforcement is to be selected as governing reinforcement in each direction. To meet code minimum reinforcement ratio (% of A_g per layer) input is entered as 0.18% of gross concrete area as opposed to 0.09% for models with two layers of reinforcement.

When Welded-Wire-Fabric (WWF) reinforcement is used, the Design Parameter Input for W9.5 wire is shown below as an example:



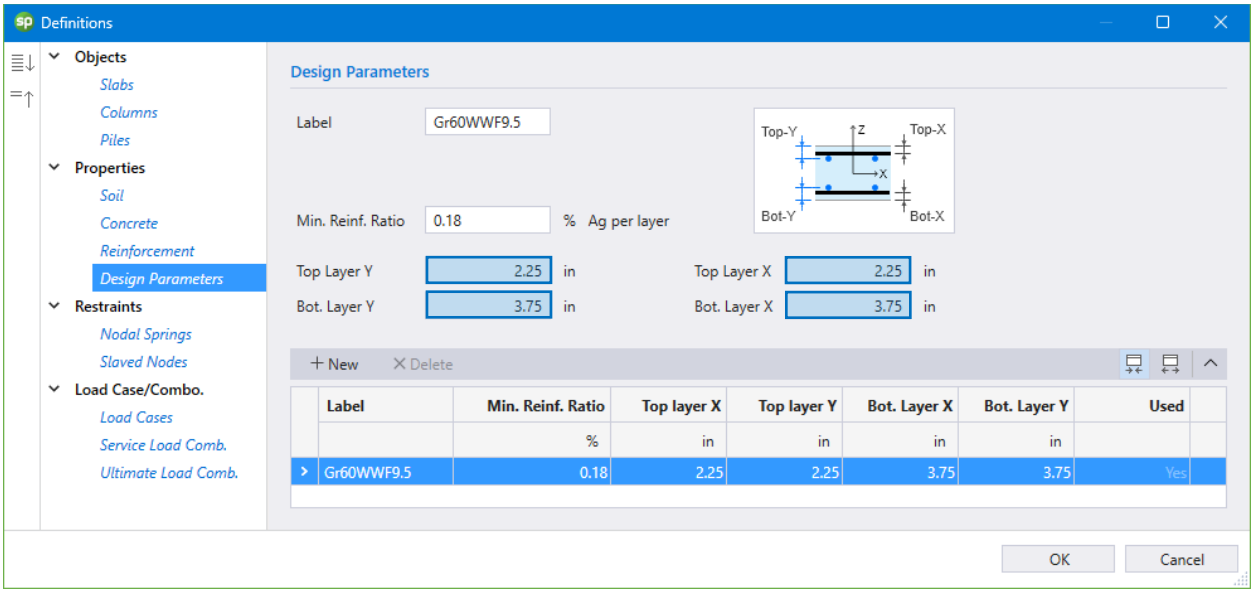


Figure 3 – Design Parameters Input – Welded-Wire-Fabric (WWF)

Interpretation of Reinforcement Output

spMats displays the required area of reinforcement as a contour view as well as a text output for each element. The contour views of required reinforcement in the X-Direction is shown below. The top layer reinforcement, $A_{sx(Top)}$, due to tension at the top of the slab indicates that minimum reinforcement (0.0018Ag) of 0.133 in^2/ft is adequate throughout by placing #4 @ 18". The bottom layer reinforcement due to tension at the bottom of the slab indicates that the minimum reinforcement of 0.130 in^2/ft is adequate for most of the slab except for an area of 2'-0" × 2'-0" under the posts.

The required amount of reinforcement for an area 2'-0" × 2'-0" under the post is the envelope of $A_{sx(Top)}$ and $A_{sx(Bottom)}$ values which is 0.212 in^2/ft times 2 ft width equaling to 0.424 in^2. Placing one additional #4 bar of length 2'-0" plus development length within that 2 ft width at the post will satisfy this design requirement [***#4@18" within 2 ft width*** (0.2 × 24/18 = 0.267 in^2) + ***1-#4*** (0.20 in^2) = 0.467 $in^2 \geq 0.424$ in^2]. The Y-Direction reinforcement is to be determined in the same manner.

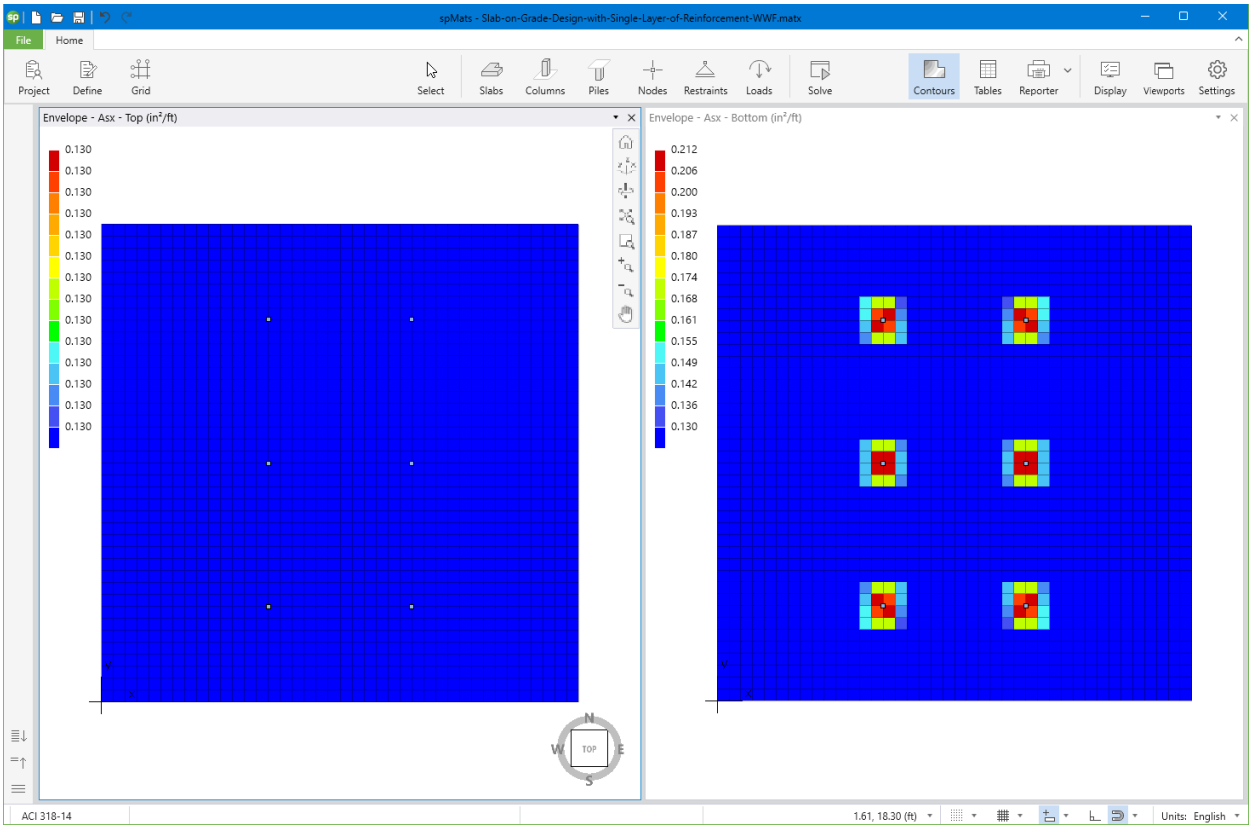


Figure 4 – Required Reinforcement Contours along X-Direction (Top and Bottom) (spMats)