ANALYSIS AND DESIGN OF FOUNDATION SLABS SUPPORTED BY DISSIMILAR SOILS

An existing L-shaped foundation slab (supported by Soil 1) will undergo expansion (supported by Soil 2). On the expansion side, the soil subgrade modulus is 100 kcf because the contractor could not match the soil properties under the existing foundation slab, which is 200 kcf. spMats v8.10 software program is utilized to investigate the impact of the dissimilar soils on the calculated bearing pressure for the combined foundation as well as other design parameters such as displacement, bending moments, and required reinforcement.

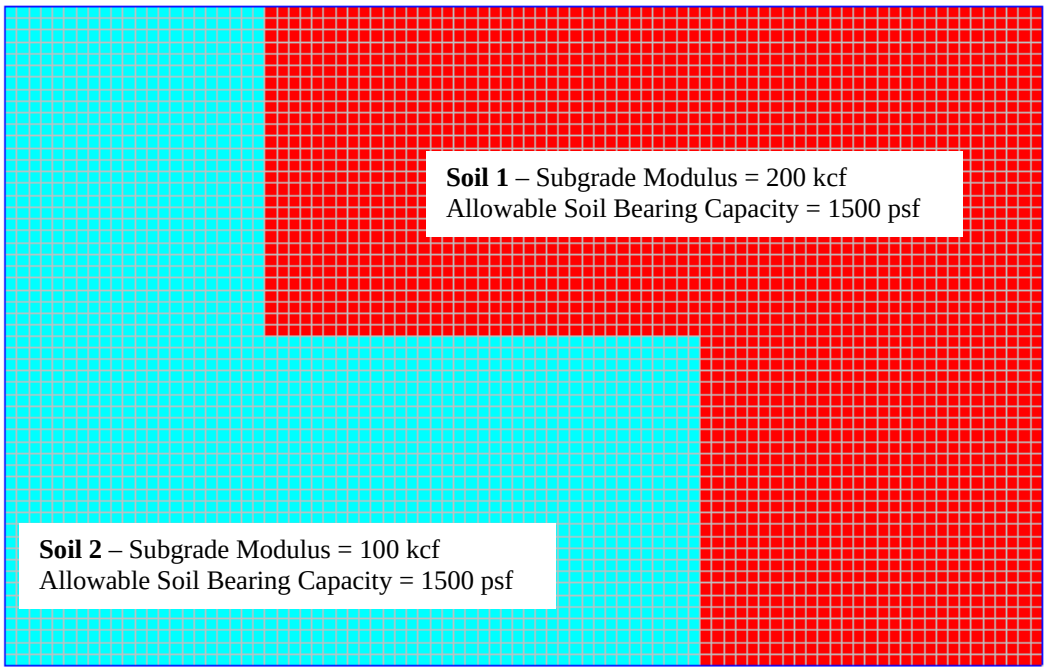

Figure 1 – Plan View of Mat Foundation Slab with Dissimilar Soils

Objective

To discuss the effect of dissimilar soil stiffness on the calculation and presentation of soil pressure in spMats v8.10. Also, to discuss changes to the graphical display as compared to prior versions.

Code

Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14)

Design Data

Mat Foundation Plan Dimensions after Expansion: 28 ft x 44 ft
Mat Foundation Thickness: 24 in
Live Load = 300 psf

Solution

Figure 2 presents the contour view of soil pressure envelope values calculated for the entire foundation slab. A detailed evaluation of this figure, in conjunction with the text output for soil displacement and pressure values, will lead to the following important observations:

1. The contour view shows an abrupt change in soil pressure envelope due to the variation in soil subgrade modulus along the dissimilar soil boundaries.
2. Higher soil pressures are evident where stiffer soil profile exists. Conversely, lower pressures are evident where less stiff soil exists.

3. Each finite element has four nodes and each node has its own soil pressure value. Envelope soil displacement and pressure text results display the soil pressure of an element based on the node with the highest soil pressure value.
4. Since the common nodes of elements along each side of dissimilar soil boundaries undergo the same displacement, pressure drop at the boundary can be related directly to the variation of soil stiffness.

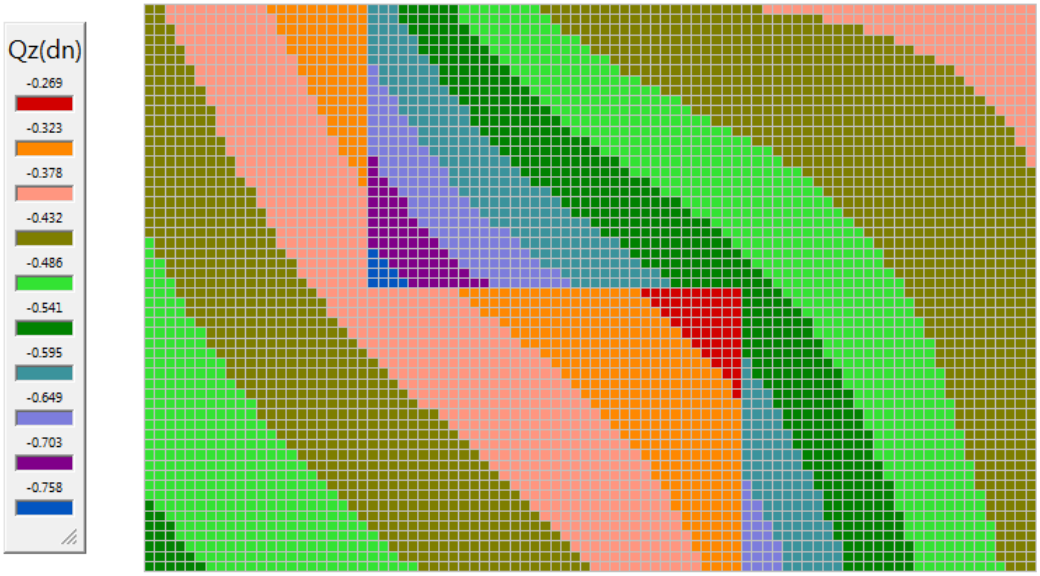

Figure 2 – Envelope Pressure Down – Soil Bearing Pressure Contours (ksf) – v8.10 and prior

Similarly, Figure 3 presents the calculated service level soil pressure values for a specific service load combination. Both figures reflect a similar trend in pressure variation owing to the same rationale discussed for the envelope soil pressure values.

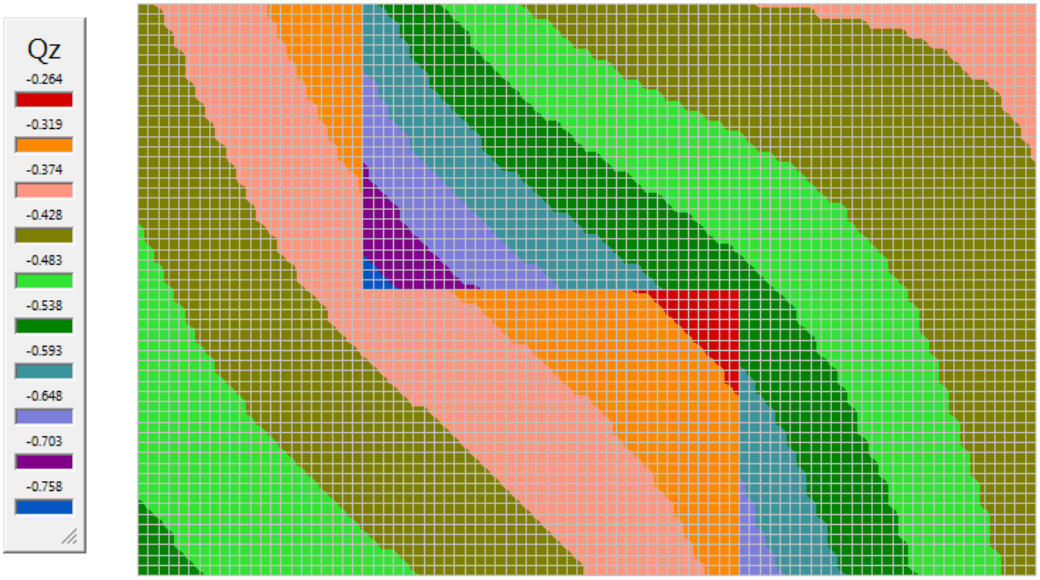

Figure 3 - Service Load Combination S1 – Soil Bearing Pressure Contours (ksf) – v8.10

Figure 4 presents the contour view of calculated service-level soil pressure values for a specific service load combination from prior versions of spMats. Along dissimilar soil boundaries, an averaging technique was used to facilitate the visualization of the nodal soil pressures for elements. However, this approach has not conveyed the exact calculated pressures as reported in the text results and on the envelope contour map. Subsequently, averaging of soil pressures at nodes has been discontinued in spMats v8.10 because no sound technical basis was found in the literature. spMats v8.10 presents the service-level soil pressure contours in agreement with the three other ways of displaying pressure value (i.e., service-level soil pressure text results, envelope soil pressure contours, and envelope soil pressure text results).

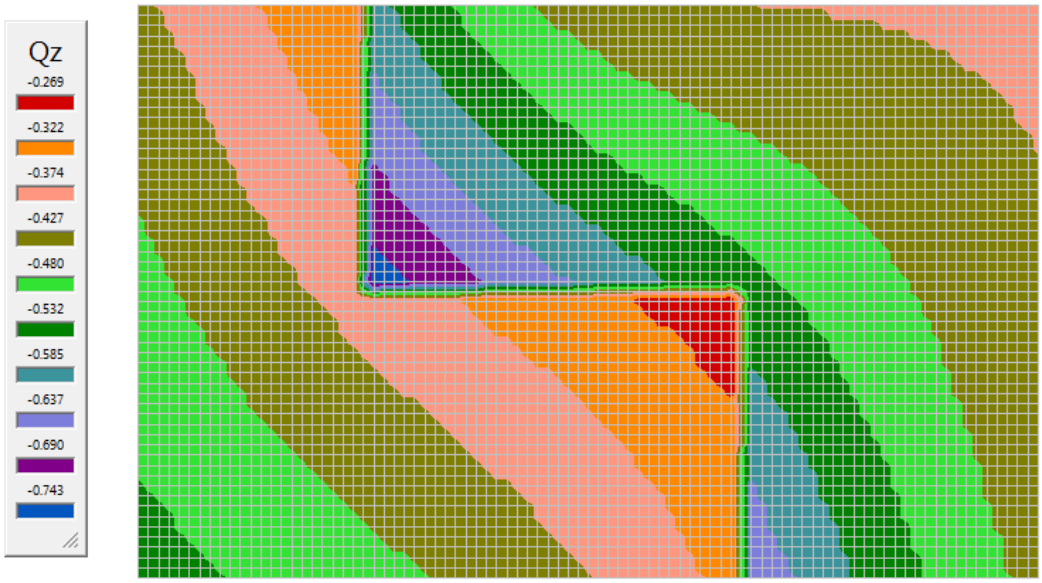

Figure 4 - Service Load Combination S1 – Soil Bearing Pressure Contours (ksf) – v7.52 and prior

Conclusions

spMats users who have designed foundation slabs with dissimilar soils should evaluate the soil pressures in detail at the dissimilar soil boundaries. Specifically, it is important to:

1. Compare soil pressure text results for individual service level combinations along dissimilar soil boundaries and make sure that they are in good agreement with the soil pressure contours of corresponding service load combinations.
2. Consider the envelope soil pressure results and contour views together, because these values provide the basis for the adequacy of the foundation as far as the soil pressure criteria is concerned.

The consideration of the two items above will ensure the successful evaluation of foundation soil pressure check in the spMats software program.