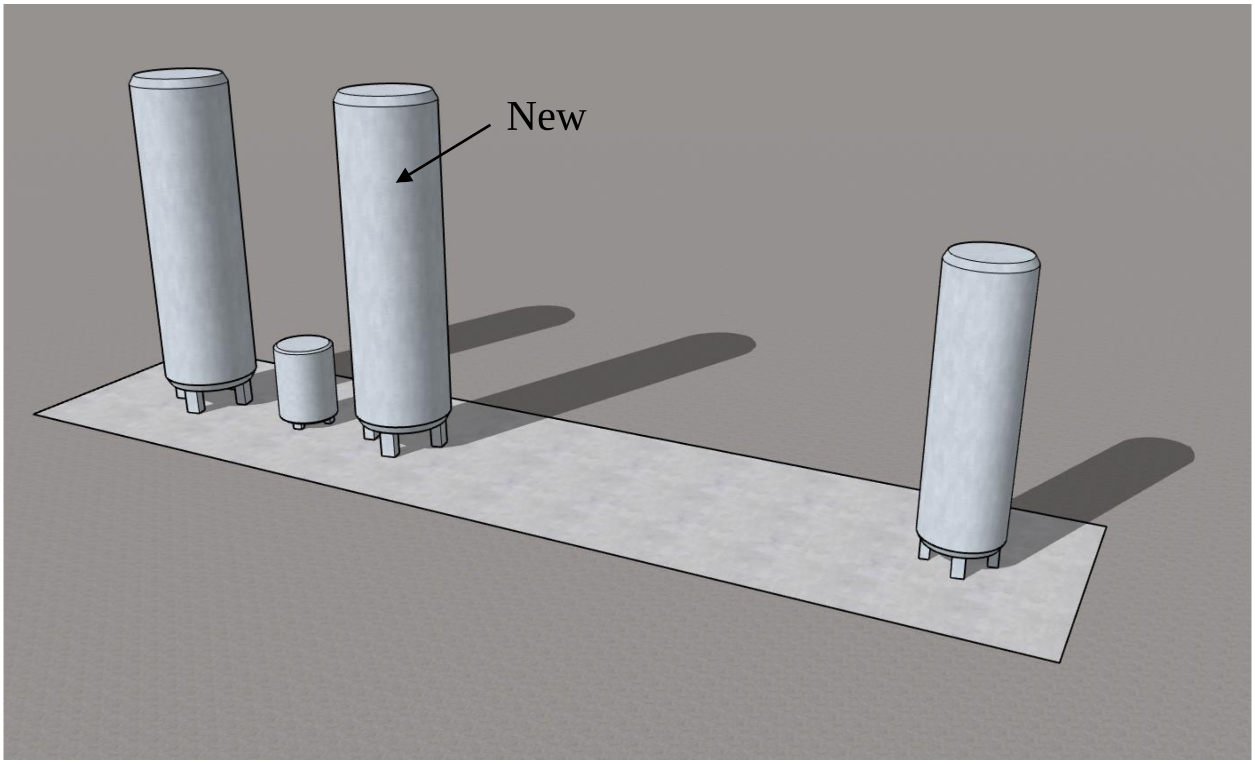
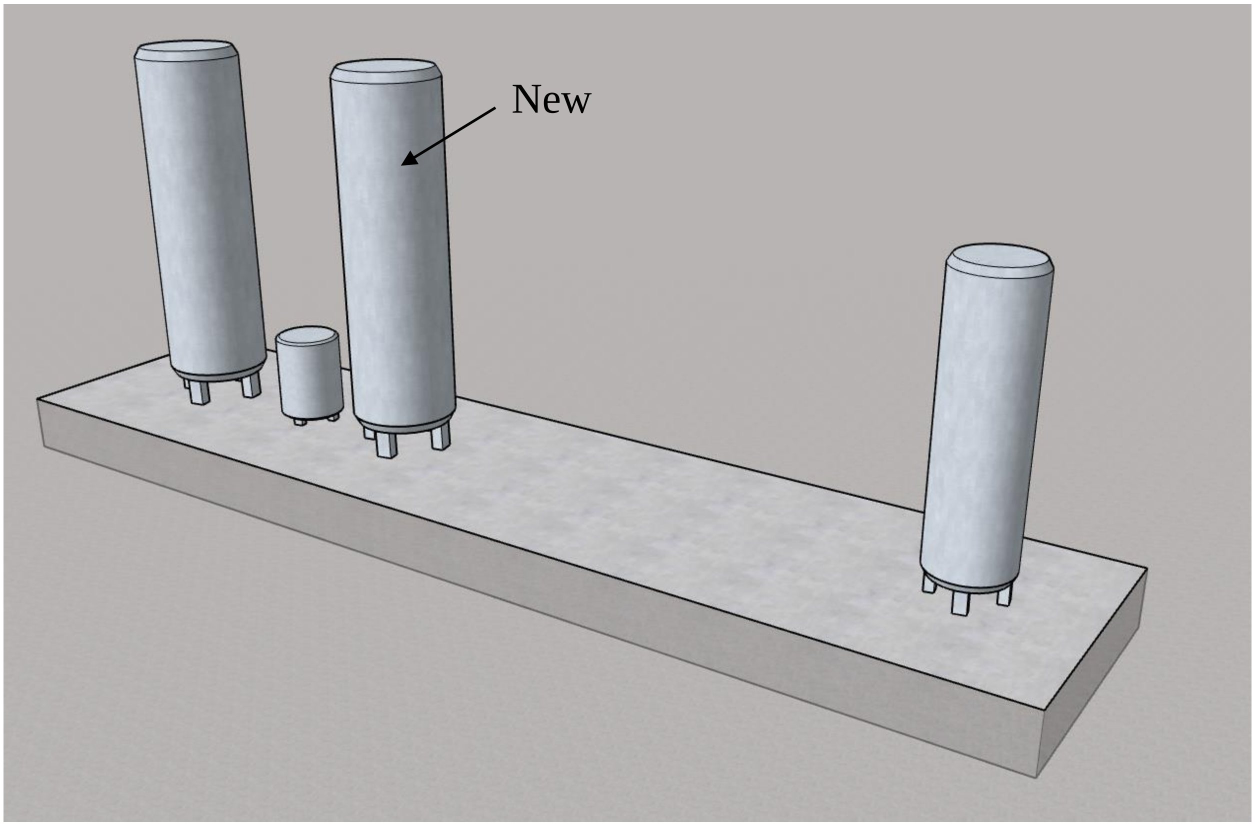
Tank Equipment Mat Foundation Analysis and Design





Industrial Tanks Foundation Analysis and Design

This case study focuses on the investigation of an existing industrial tanks foundation using the engineering software program spMats. The information provided to the structural engineer regarding the existing industrial tank foundation and the new tank intended to be erected over the same foundation are shown in the following figure. The loading data and cross section and will serve as input for foundation analysis and design. The intent is to assess the adequacy of the existing mat slab foundation to accommodate the new loading from the additional tank.

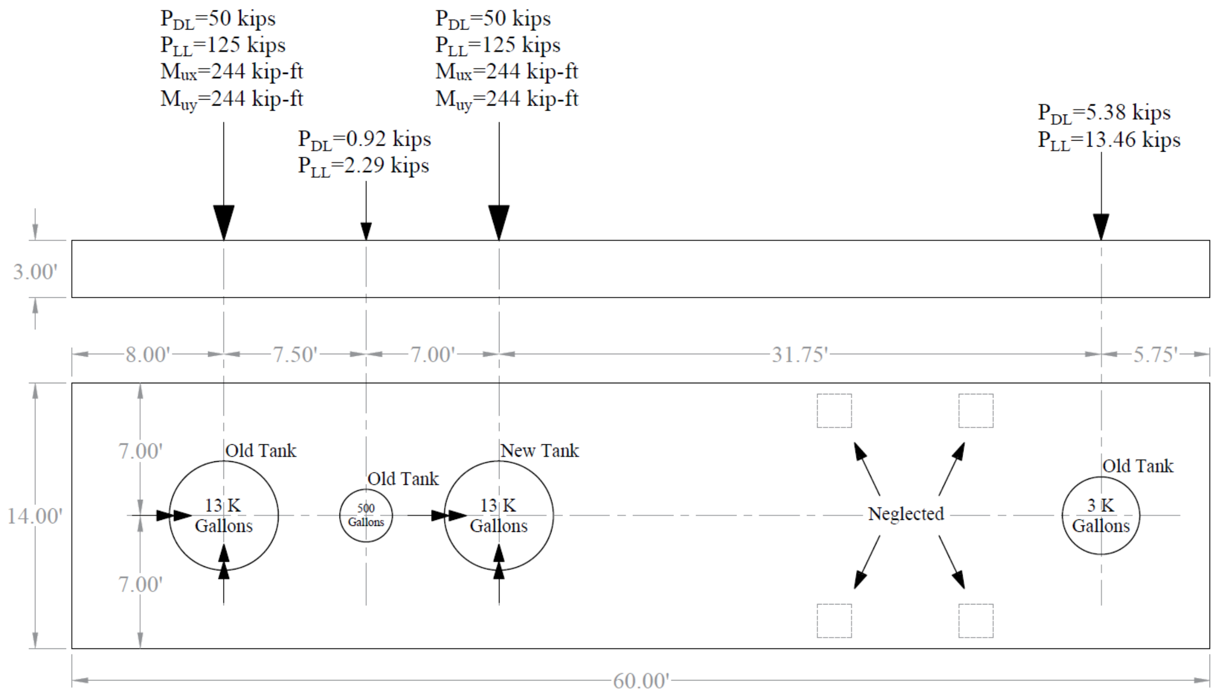


Figure 1 – Industrial Equipment Mat Foundation Layout & Loads

Code

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

Reference

spMats Engineering Software Program Manual v8.50, StucturePoint LLC., 2016

Design Data

Size = 60 ft x 14 ft

Thickness = 3 ft

Cover = 1.5 in.

f_c' = 4,000 psi

f_y = 60,000 psi

Allowable Soil Pressure = 3 ksf

Load Case	Loads			
	P_{13k}, kips	M_{13k}, kip-ft	P_{3k}, kips	P_{500}, kips
Dead	50.00	---	5.38	0.92
Live	125.00	---	13.46	2.29
Ultimate	---	244.00*	---	---
* Moment about x- and y-axis				

Foundation Analysis and Design – spMats Software

spMats uses the Finite Element Method for the structural modeling, analysis and design of reinforced concrete slab systems or mat foundations subject to static loading conditions.

The slab, mat, or footing is idealized as a mesh of rectangular elements interconnected at the corner nodes. The same mesh applies to the underlying soil with the soil stiffness concentrated at the nodes. Slabs of irregular geometry can be idealized to conform to geometry with rectangular boundaries. Even though slab and soil properties can vary between elements, they are assumed uniform within each element. Piles are modeled as springs connected to the nodes of the finite element model. Unlike for springs, however, punching shear check is performed around piles.

For illustration and purposes, the following figures provide a sample of the input modules and results obtained from spMats models created for the industrial tanks foundation this case study.

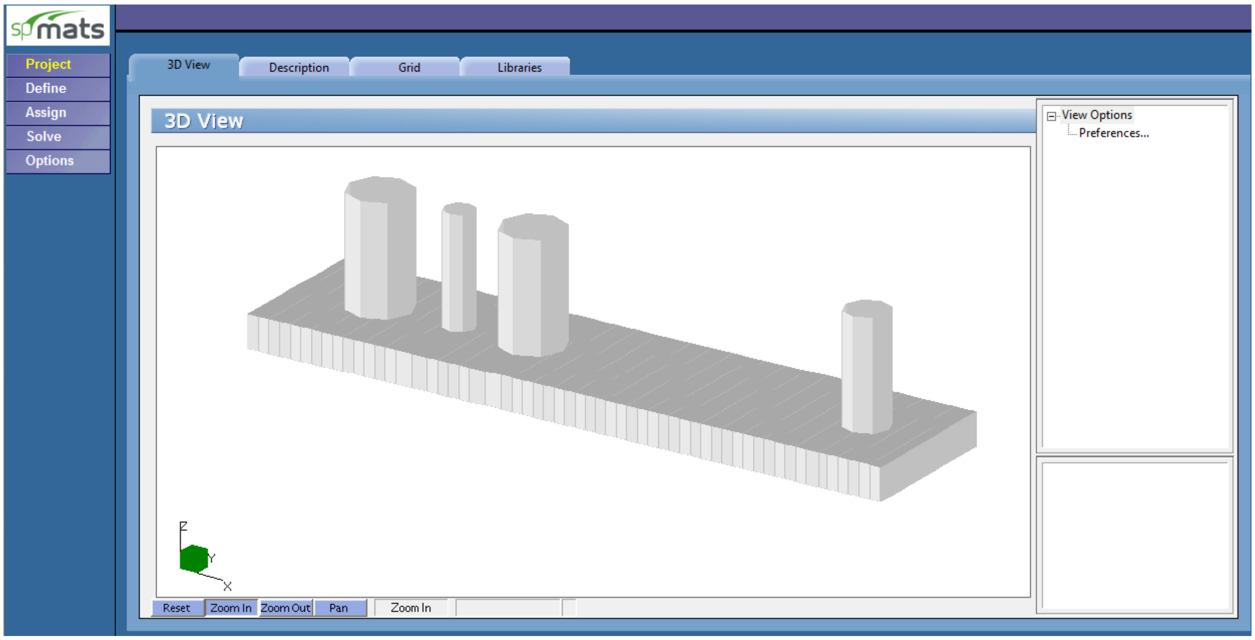
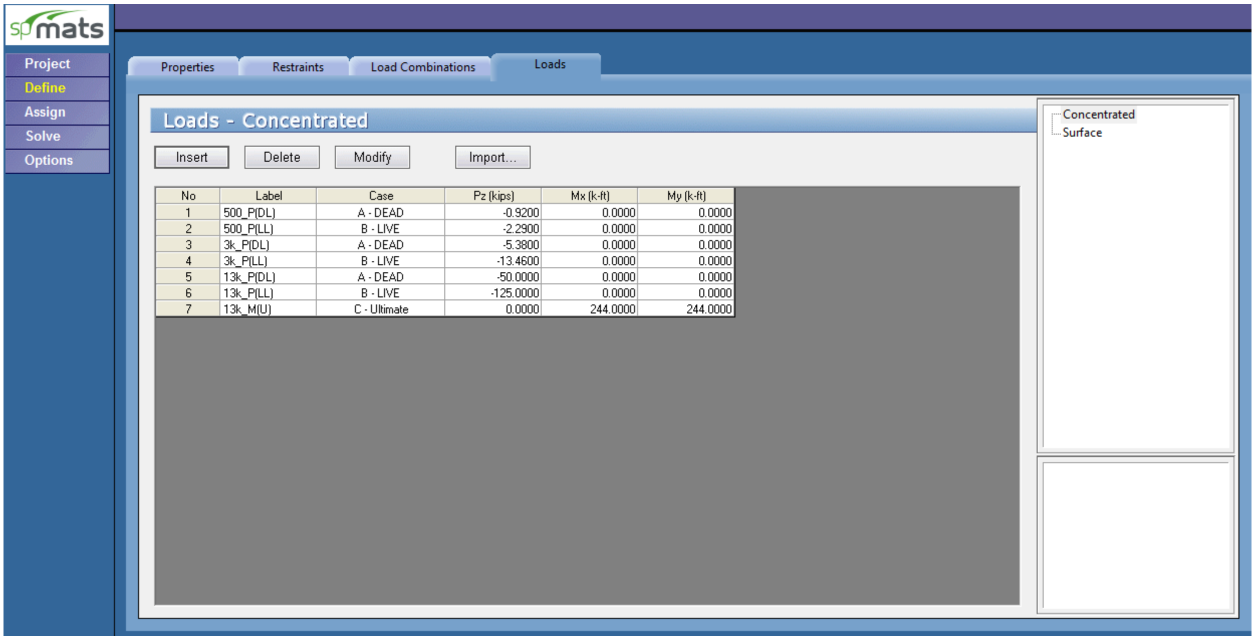


Figure 2 – Industrial Tanks Mat Foundation - 3D View



No	Label	Case	Pz (kips)	Mx (k-ft)	My (k-ft)
1	500_P(DL)	A - DEAD	-0.9200	0.0000	0.0000
2	500_P(LL)	B - LIVE	-2.2900	0.0000	0.0000
3	3k_P(DL)	A - DEAD	-5.3800	0.0000	0.0000
4	3k_P(LL)	B - LIVE	-13.4600	0.0000	0.0000
5	13k_P(DL)	A - DEAD	-50.0000	0.0000	0.0000
6	13k_P(LL)	B - LIVE	-125.0000	0.0000	0.0000
7	13k_M(U)	C - Ultimate	0.0000	244.0000	244.0000

Figure 3 – Defining Loads

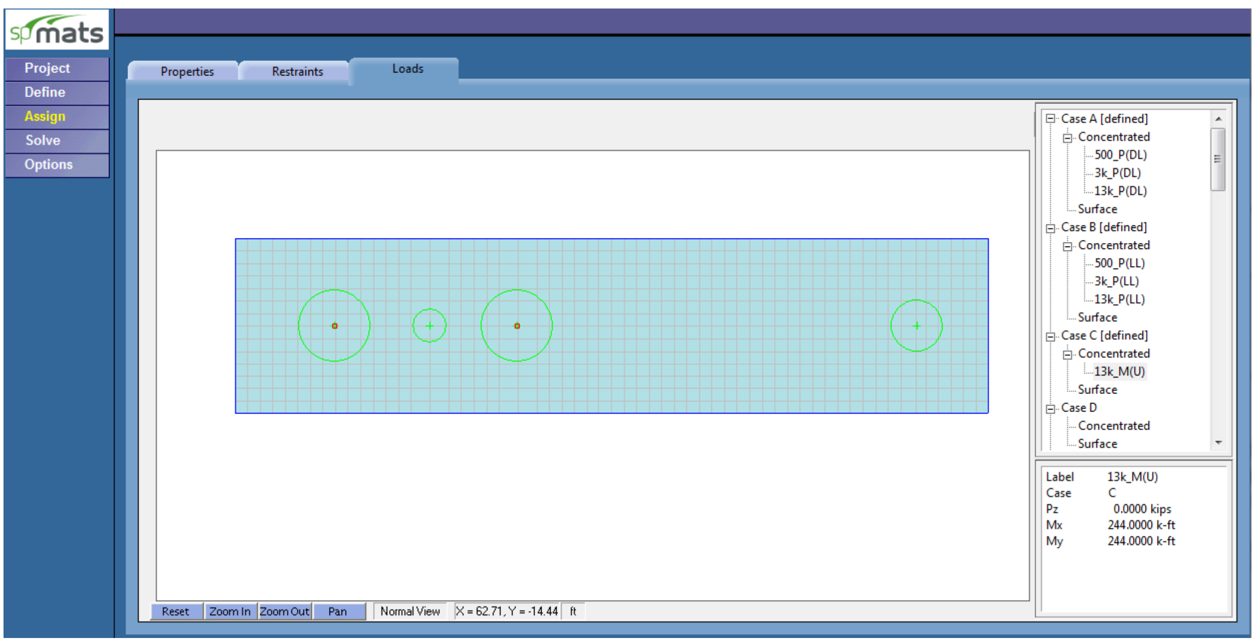


Figure 4 – Assigning Loads

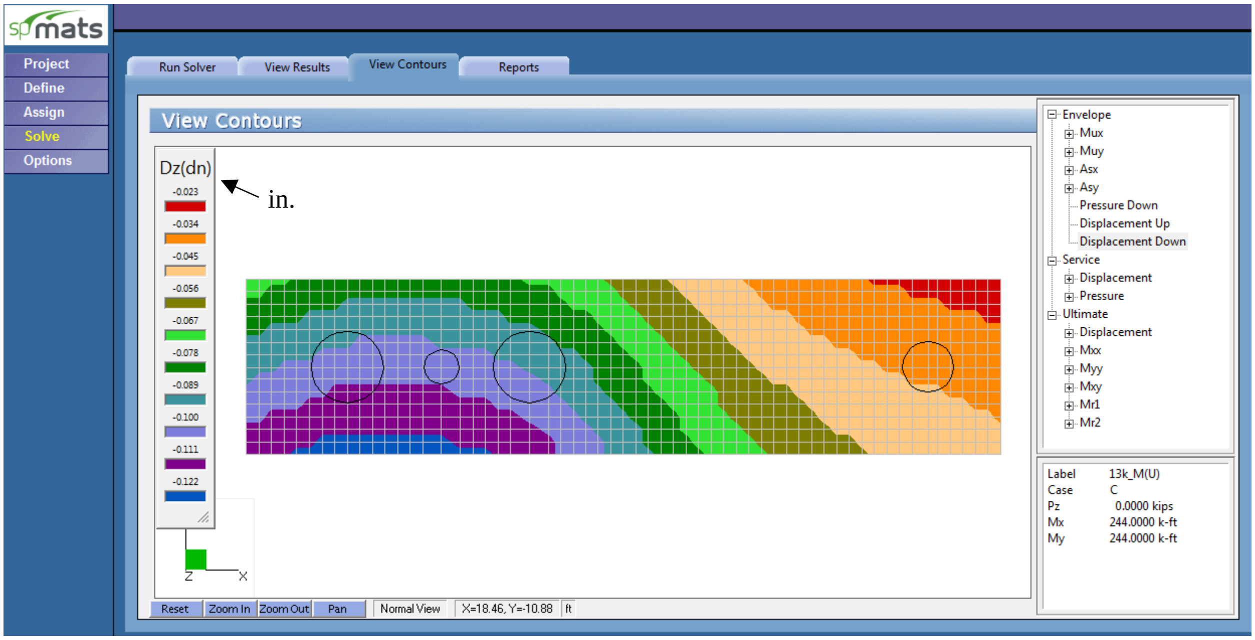


Figure 5 – Vertical Displacement Contours

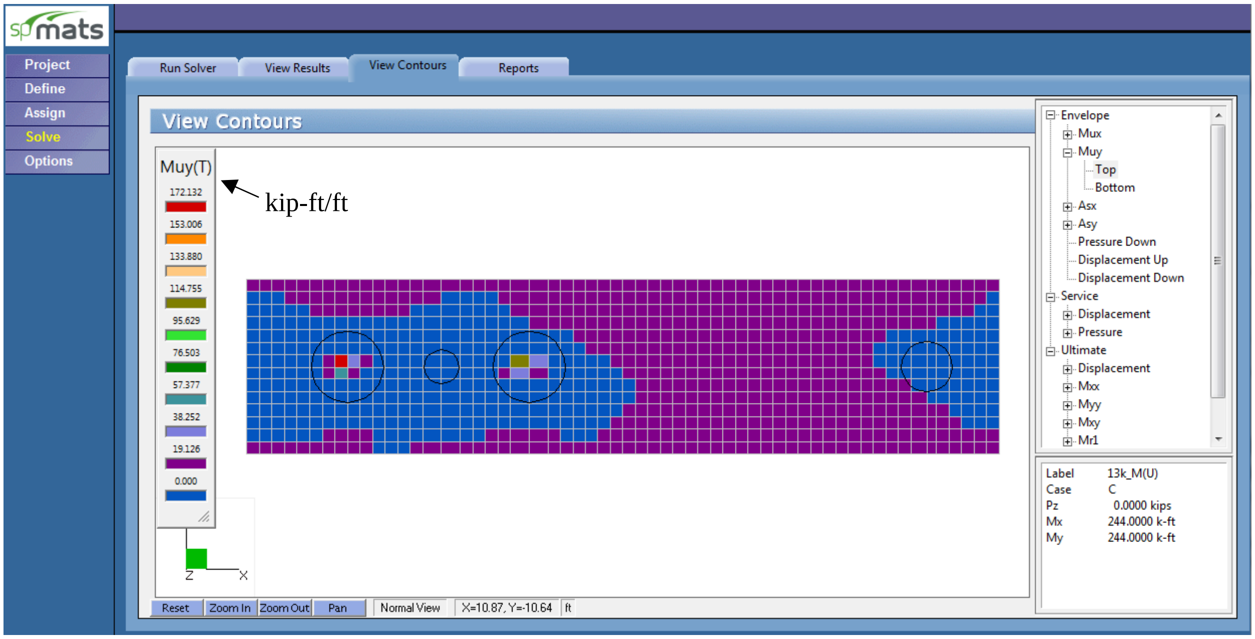


Figure 6 – Moment Contours along Y-Axis

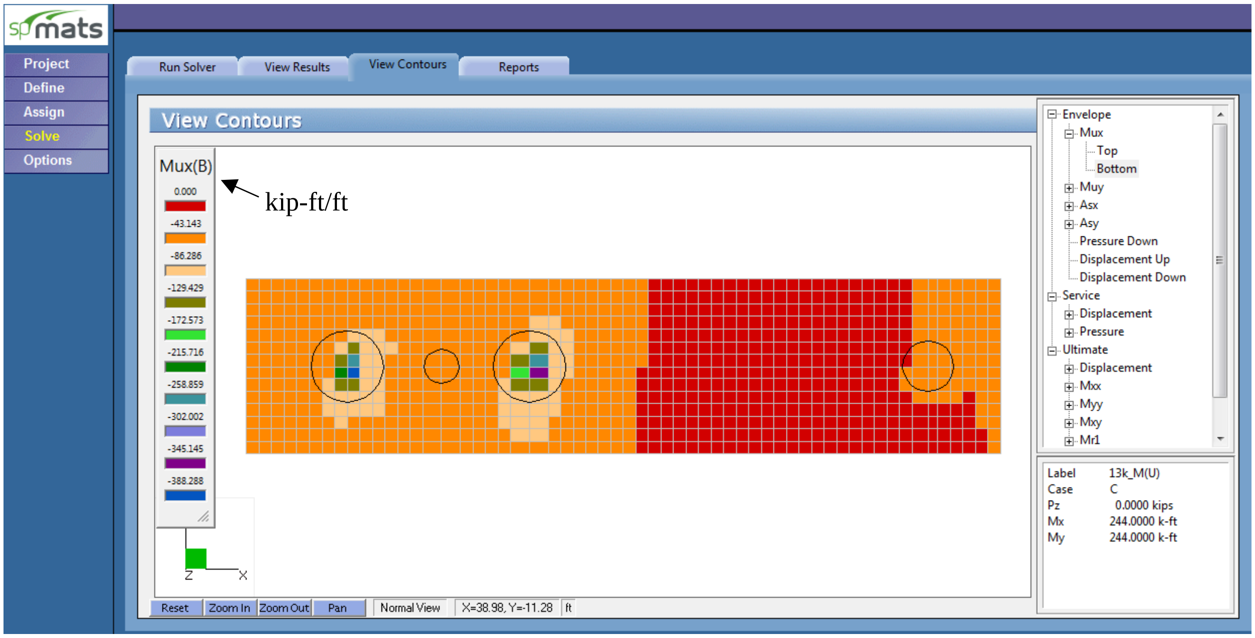


Figure 7 – Moment Contours along X-Axis

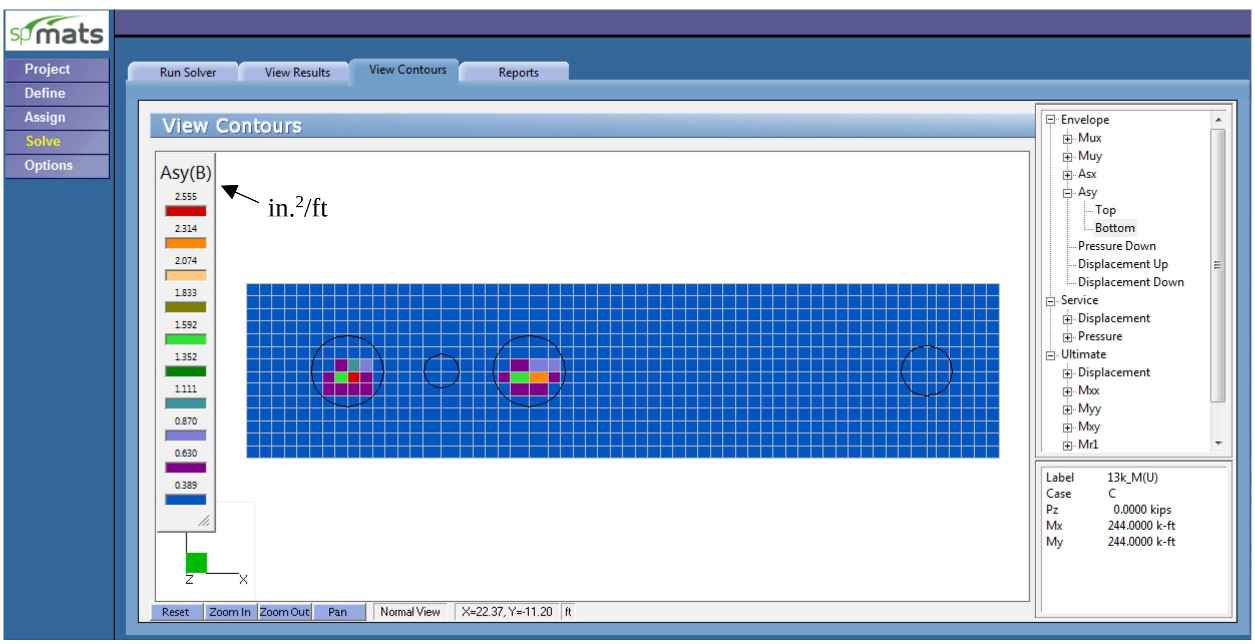


Figure 8 – Required Reinforcement Contours along Y Direction

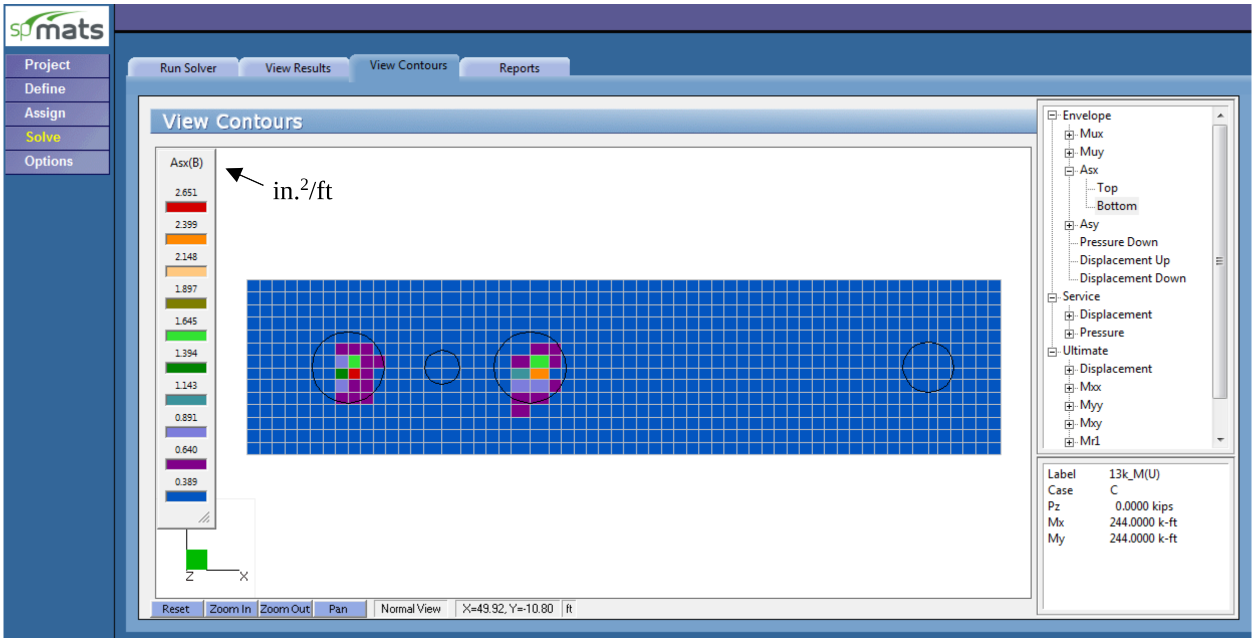


Figure 9 – Required Reinforcement Contours along X Direction

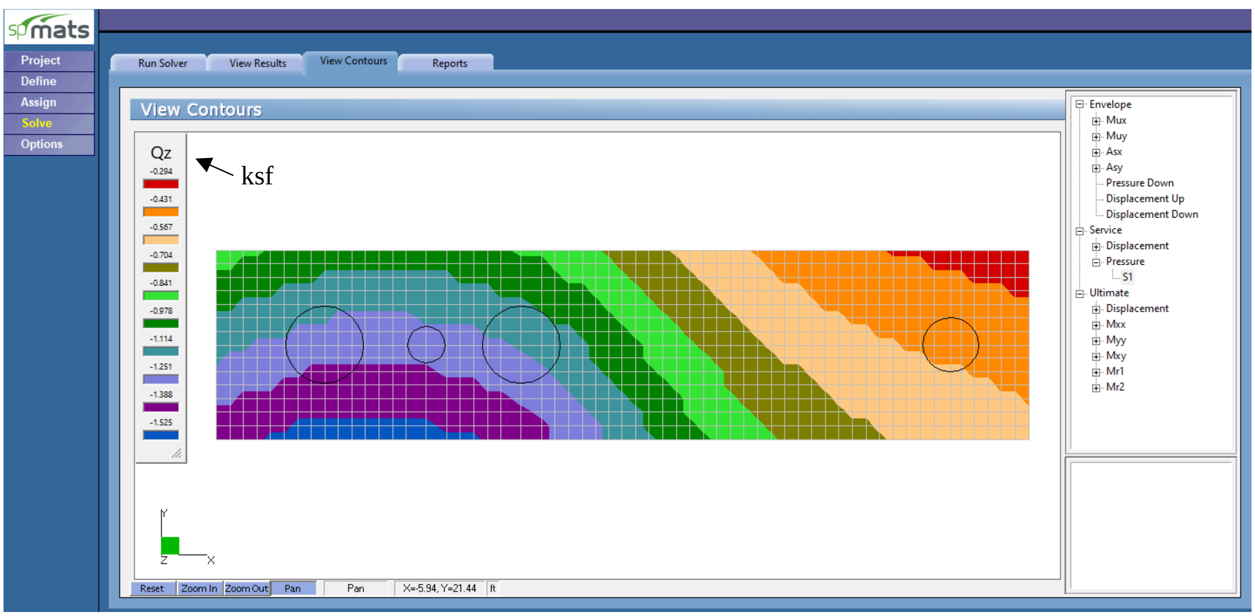


Figure 10 – Soil Pressure

Conclusions

spMats is a finite element program where results are highly dependent on engineering judgement and assumptions made in the process of creating the model. The following notes can help the engineer in obtaining the optimal design using spMats:

1) The tank loads were applied in this model as point loads which might cause stress concentration at the node where the loads are applied. The tank load can be distributed as a point loads under each of the four legs while the moment can be divided as a force couple. This step can help in lowering the impact of concentration of soil pressure, displacement and reinforcement.

2) Multiple load combinations can be added to take into account the reversibility of the moment and considering moments in the x- and y- direction individually.

3) If each tank leg was simulated as a point load, punching shear can be checked in spMats.

4) Soil pressure contour reveals a maximum soil pressure of 1.5 ksf which is less than the allowable (3 ksf).