CHAPTER 5: Conclusions and Recommendations

5.1 Conclusions

A three-dimensional study was performed on a geotextile tube resting on an elastic foundation. The geotextile tube and its elastic foundation were modeled using the finite element analysis program ABAQUS. The tube was modeled as initially flat and during the analysis, internal hydrostatic pressure was applied to the structure. The weight of the geotextile was included.

Two cases were studied; the first had a flat length-to-width ratio of 2:1 and the other had a flat length-to-width ratio of 5:1. In each case, the tube was modeled resting on elastic foundations with two different distributed spring stiffnesses; one distributed spring stiffness was 4.20×10^6 N/m^3 and the other was 8.40×10^4 N/m^3. The shape of the slurry-filled model was studied along with the contact region between the tube and its elastic foundation, the stresses which formed in the geotextile, and the relationship between the amount of applied pressure and the height of the tube.

Based upon the results obtained from the models, with one exception, the region of contact between a geotextile tube and its elastic foundation decreases as the hydrostatic pressure increases.

For the 2:1 flat length-to-width ratio case and the 5:1 case, mid-surface stresses along the length follow the same trend. The mid-surface stress σ_{22} is almost zero near the center of the tube and is negative (compression) at the edge of the tube. For all cases except for the 5:1 case with a distributed spring stiffness of 8.40×10^4 N/m^3, the tube changes from being in tension to compression, back to tension, and into compression again at the edge. This is due to wrinkling in the model. The reason for the exception is that a considerable lower pressure head was applied to the model in that particular case.

The mid-surface stress σ_{11} along the length follows the same trend in both the 2:1 flat length-to-width ratio case and the 5:1 case. In both cases, σ_{11} at the center of the top surface is positive (tension) and at the edge is approximately zero. The only difference is that in the 2:1 case σ_{11} at the center of the bottom surface is positive (tension) whereas in the 5:1 case it is zero.

The mid-surface stresses along the Y-axis for the 2:1 length-to-width ratio case and the 5:1 case do not follow the same trends. For the 2:1 case, the mid-surface stress σ_{11} is in tension and constant near the center of the tube. Due to wrinkling in the tube, on the top surface, σ_{11} changes from being in tension to compression, to tension again, and then back to compression at the edge. The mid-surface stress σ_{22} is almost zero at the edge, along the top surface, and along the bottom surface of the tube. Where uplift occurs on the bottom surface, σ_{22} is positive (tension) for a distributed spring stiffness of 8.40×10^4 N/m^3 and zero for a distributed spring stiffness of 4.20×10^6 N/m^3.

For the 5:1 length-to-width ratio case, the mid-surface stress σ_{11} is positive (tension) at the center of the top surface and negative (compression) at the edge. For a distributed spring stiffness of 4.20×10^6 N/m^3, σ_{11} is negative (compression) at the center of the bottom surface. For a distributed spring stiffness of 8.40×10^4 N/m^3, σ_{11} is zero at the center of the bottom surface. For both distributed spring stiffnesses, the mid-surface stress σ_{22} is almost zero along the top and bottom surfaces and at the edge.

The pressure vs. height plots for both the 2:1 flat length-to-width ratio case and the 5:1 case are shown together in Figure 5.1.1. In the figure, K = 10,000 N/m and K = 200 N/m correspond to $K_d = 4.20 \times 10^6$ N/m^3 and $K_d = 8.40 \times 10^4$ N/m^3, respectively. This figure shows that for the 2:1 case, at a given hydrostatic pressure, the height of the geotextile tube, measured from the reference ground level, increases as the stiffness of the elastic foundation increases. For the 5:1 case, the stiffness of the elastic foundation does not appear to have an effect on the height of the tube, although in this particular instance, no final conclusions can be made. The reason for this is that the model with a distributed spring stiffness of 8.40 x 10^4 N/m^3 had a maximum pressure head of 0.4m applied to the model, whereas the model with the distributed spring stiffness of 4.20 x 10^6 N/m^3 had a maximum applied pressure head of 0.7m. In general, as the flat length of a geotextile tube increases, the height of the tube, measured from the reference ground level, increases.

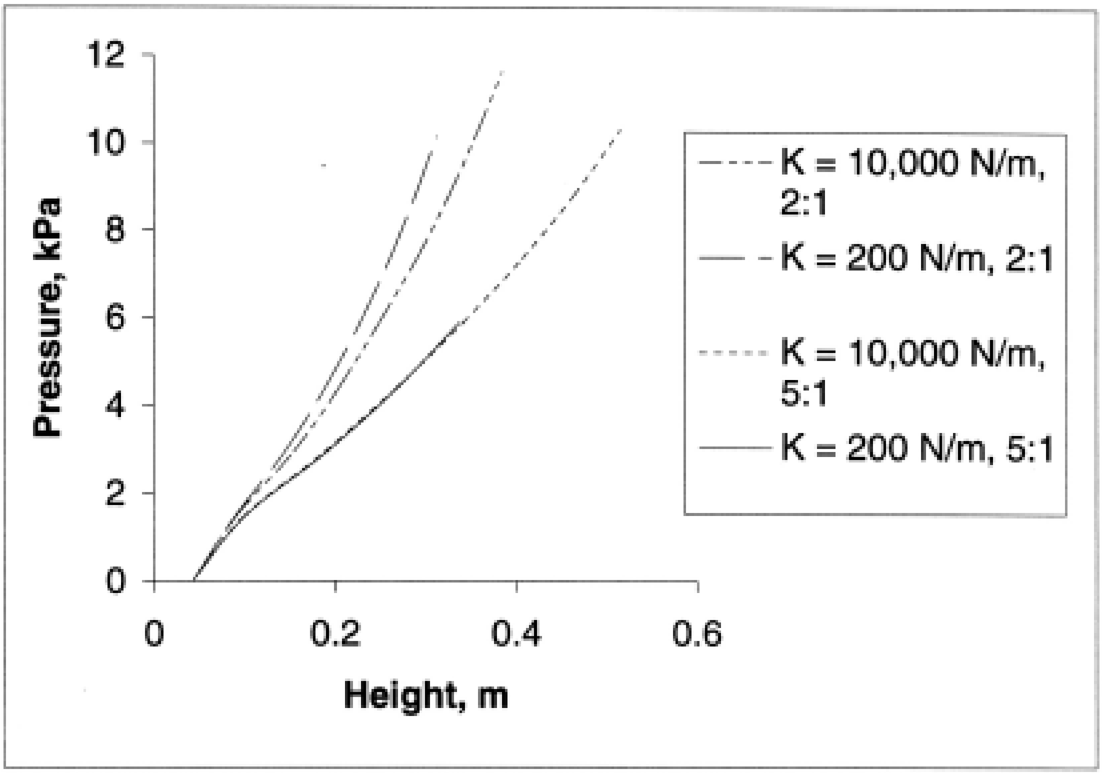

Figure 5.1.1: Pressure vs. Height for Both 2:1 and 5:1 Length-to-Width Ratio Cases

5.2 Recommendations for Further Research

There are several aspects of the geotextile tube that can be researched further. First, the soil underneath the tube can be modeled so that the stiffness is not assumed to be constant. Two- and three-dimensional studies can be performed on stacked tubes, as this commonly occurs in practical applications. The geotextile tube can be modeled with water applied to one side of it. The geotextile can be modeled as a permeable material, and the permeation of material out of the tube can be included in the model.