CALCULATION: EXAMPLE 2

Introduction

PowerFoam Geofoam is used in a wide range of structural and civil engineering applications. The selection of the appropriate grade of PowerFoam Geofoam for a specific application is a critical decision to ensure suitable long term performance.

PowerFoam Geofoam is a structural material produced in compliance with ASTM D6817, "Standard Specification for Rigid Cellular Geofoam". PowerFoam Geofoam is available in 7 standard grades with compressive resistance @1 % strain ranging from 320 to 2,680 psf where the compressive resistance at 1% is the industry accepted allowable stress for the combination of dead and live loads for geofoam.

Disclaimer

This geofoam selection example is being provided to illustrate a simplified method for the calculation of vertical stress on geofoam in a hypothetical example. This simplified method is being provided only as an example and should not be relied upon for the selection of PowerFoam Geofoam for a particular project. In applications where a concrete load distribution slab is used above the geofoam, more advanced load distribution analysis methods such as finite element modeling are recommended.

The selection and/or specification of a PowerFoam Geofoam grade for a specific application should be determined by a qualified civil engineer who is acquainted with all possible aspects of a particular project.

Example

A project is proposed to be built using geofoam with a cross section and loads as shown in Figure 1. PowerFoam Geofoam EPS 22 Geofoam is proposed to be used. Vertical loads must be calculated to ensure PowerFoam Geofoam EPS 22 Geofoam is appropriate.

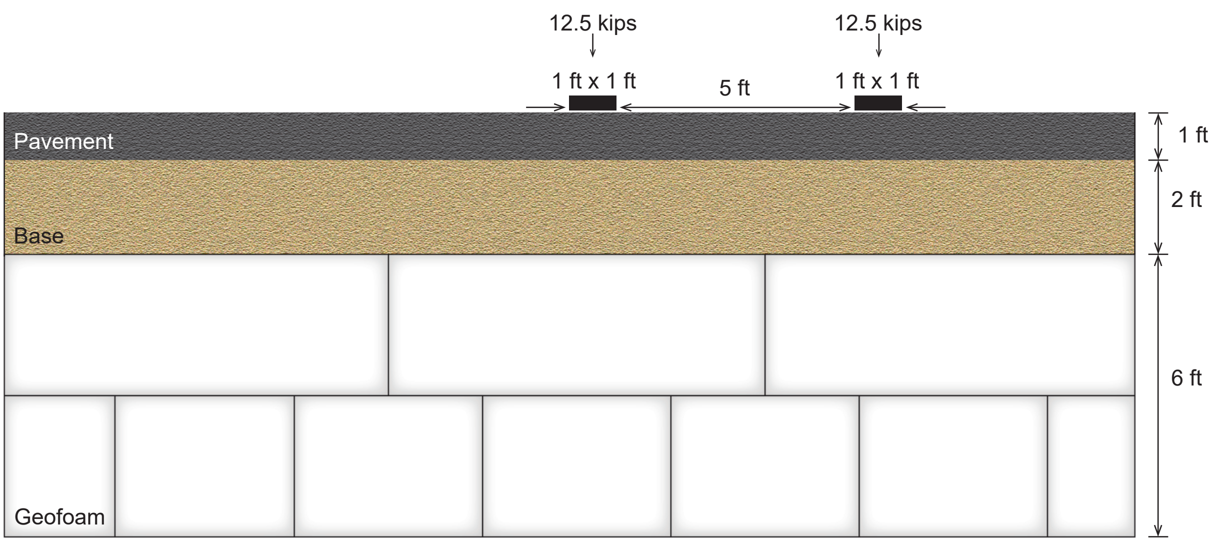

Figure 1. Project Section

Analysis Method

A simplified vertical stress distribution model is shown in Figure 2 and Figure 3 based on NCHRP published literature[1].

Transverse Load Distribution

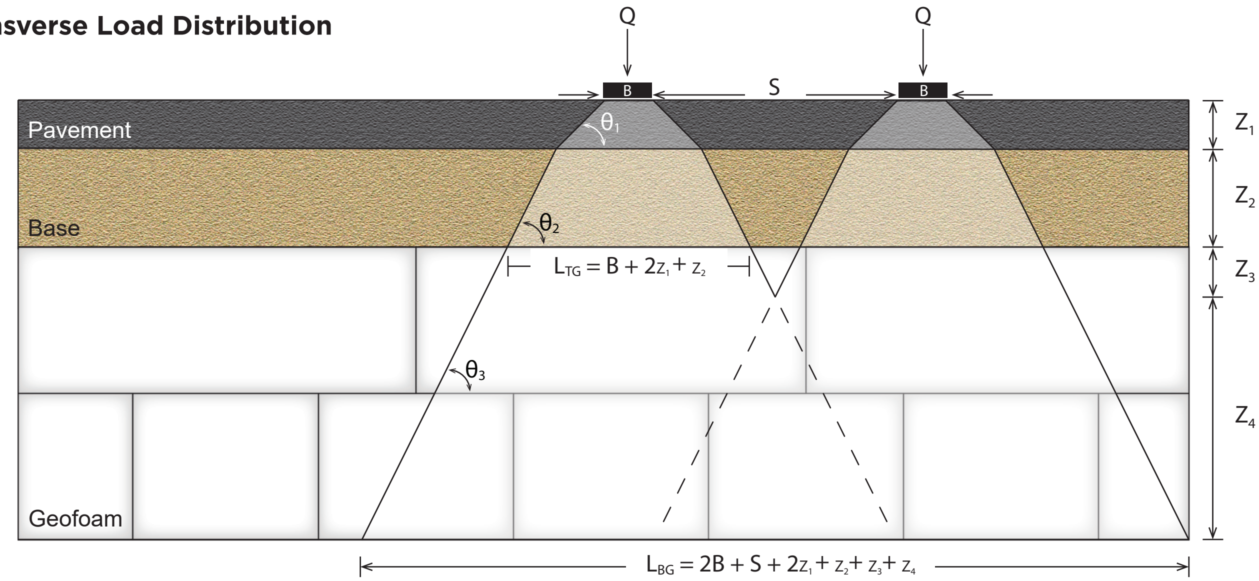

Figure 2. Simplified vertical stress distribution

Longitudinal Load Distribution

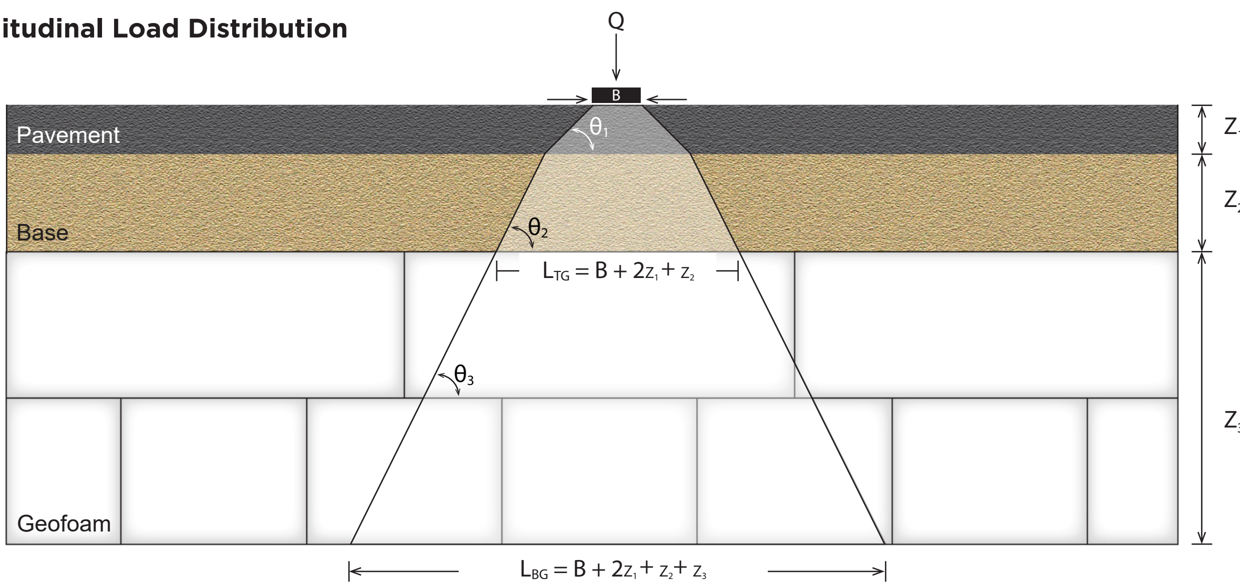

Figure 3. Simplified vertical stress distribution

Q = loading

B = equivalent width of loading in the transverse or longitudinal direction

S = spacing between inside edge of equivalent width of loading

θ_1 = 1H:1V slope

θ_2 = 1H:2V slope

θ_3 = 1H:2V slope

z_1 = thickness of pavement

z_2 = thickness of road base

z_3 = depth within geofoam

z_4 = depth within geofoam

Reference

[1] NCHRP Web Document 65 (Project 24-11) Geofoam Applications in Design and Construction of Highway Embankments, National Cooperative Highway Research Program, July 2004

Calculation – Dead Loads

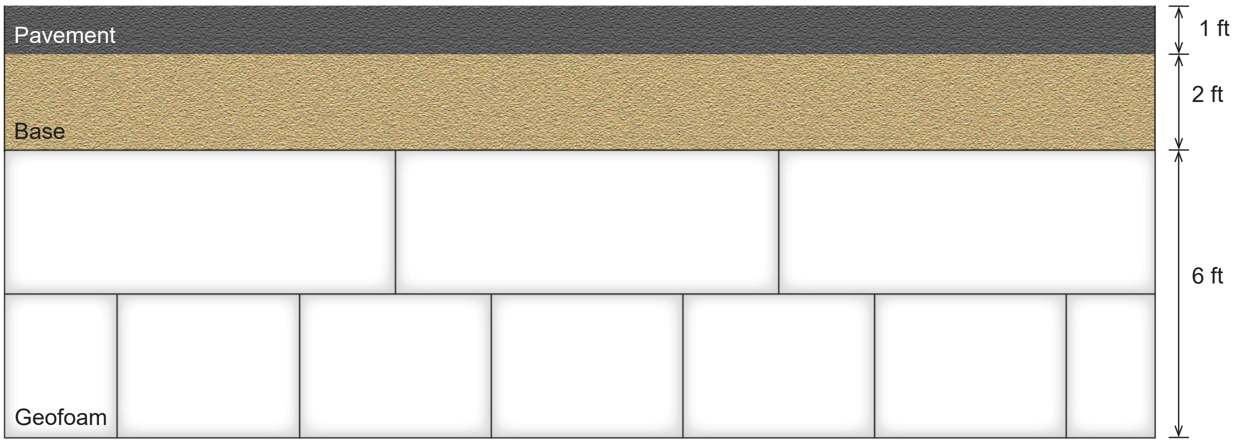

Figure 4. Calculations for dead loads

Dead load at top of geofoam:

$\sigma_{DL\ TG} = z_1 * \gamma_{Pavement} + z_2 * \gamma_{Base}$

where $\gamma_{Pavement}$ and γ_{Base} = unit weight of pavement and base, respectively

$\sigma_{DL\ TG}$ = 1 ft * 145 lbs/ft^3 + 2 ft * 140 lbs/ft^3 = 425 lbs/ft^2

$\sigma_{DL\ TG}$ = (425 lbs/ft^3) / (144 in^2/ft^2) = 2.95 psi

Dead load at beginning of overlap depth of geofoam: (see Figure 5)

$\sigma_{DL\ BG} = z_1 * \gamma_{Pavement} + z_2 * \gamma_{Base} + z_{GEOFOAM} * \gamma_{GEOFOAM}$

where $\gamma_{Pavement}$ and γ_{Base} and $\gamma_{GEOFOAM}$ = unit weight of pavement, base, and geofoam, respectively

$\sigma_{DL\ BG}$ = 1 ft * 145 lbs/ft^3 + 2 ft * 140 lbs/ft^3 + 1 ft * 1.35 lbs/ft^3 = 426 lbs/ft^2

$\sigma_{DL\ BG}$ = (426 lbs/ft^2) / (144 in^2/ft^2) = 2.96 psi

Dead load at bottom of geofoam:

$\sigma_{DL\ BG} = z_1 * \gamma_{Pavement} + z_2 * \gamma_{Base} + z_{GEOFOAM} * \gamma_{GEOFOAM}$

where $\gamma_{Pavement}$ and γ_{Base} and $\gamma_{GEOFOAM}$ = unit weight of pavement, base, and geofoam, respectively

$\sigma_{DL\ BG}$ = 1 ft * 145 lbs/ft^3 + 2 ft * 140 lbs/ft^3 + 6 ft * 1.35 lbs/ft^3 = 433 lbs/ft^2

$\sigma_{DL\ BG}$ = (433 lbs/ft^2) / (144 in^2/ft^2) = 3.01 psi

Calculation – Live Load Transverse

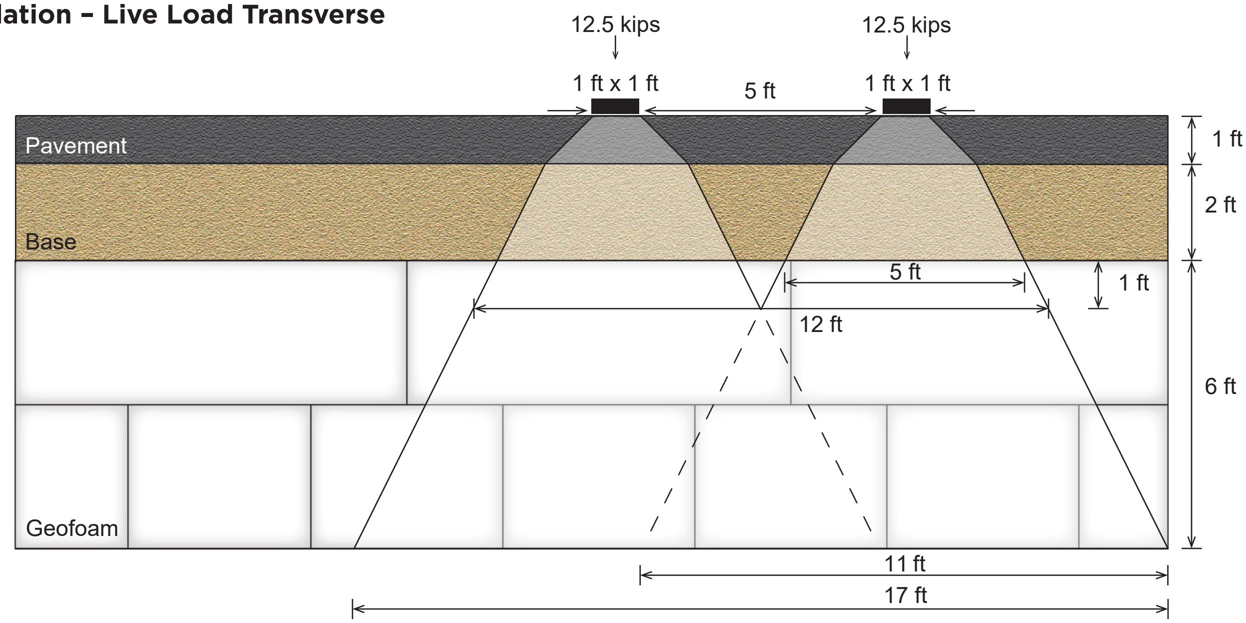

Figure 5. Calculations for live loads

Live load width at top of geofoam:

$L_{TG} = B + 2z_1 + z_2$

$L_{TG} = 1\text{ ft} + 2 * 1\text{ ft} + 2\text{ ft} = 5\text{ ft}$

Live load width at beginning of overlap depth of vertical stress distributions from 2 transverse surface loads

$L_{OD} = 2B + S + 2z_1 + z_2 + z_3$

$L_{OD} = 2 * 1\text{ ft} + 5\text{ ft} + 2 * 1\text{ ft} + 2\text{ ft} + 1\text{ ft} = 12\text{ ft}$

Live load width at bottom of geofoam:

$L_{BG} = 2B + S + 2z_1 + z_2 + z_3 + z_4$

$L_{BG} = 2 * 1\text{ ft} + 5\text{ ft} + 2 * 1\text{ ft} + 2\text{ ft} + 1\text{ ft} + 5\text{ ft} = 17\text{ft}$

Note: Loads are shown calculated at top, beginning of overlap, and bottom of geofoam only here for simplicity, but the load at any depth in geofoam can be calculated following a similar method.

Calculation – Live Load Longitudinal

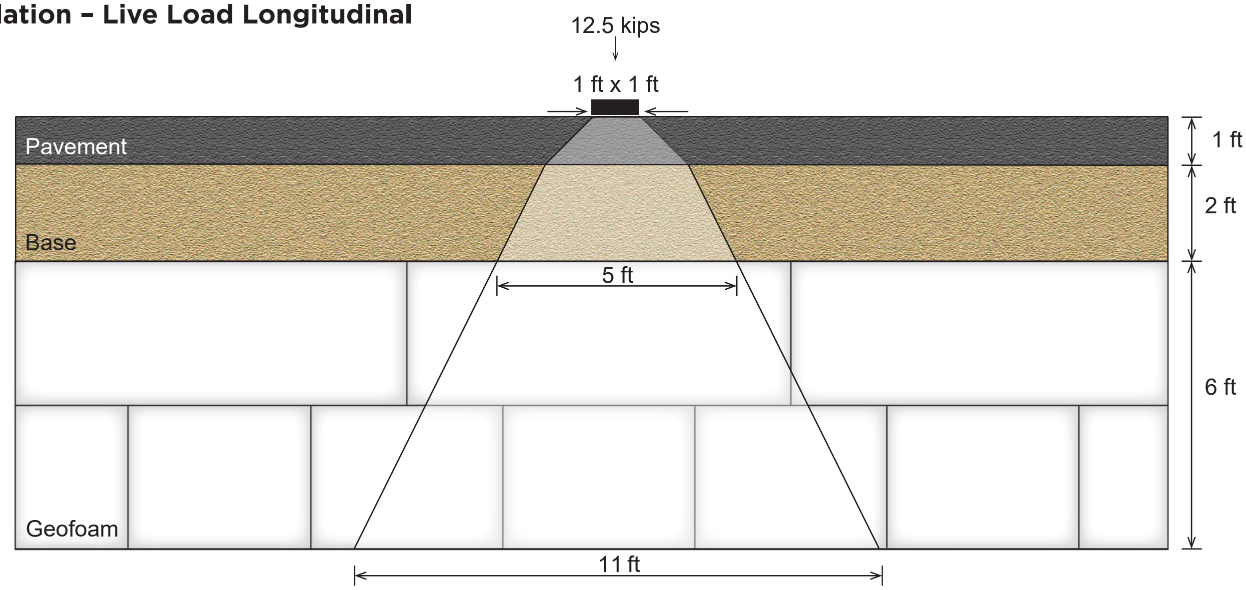

Figure 6. Calculations for live loads

Live load width at top of geofoam:

$L_{TG} = B + 2z_1 + z_2$

L_{TG} = 1 ft + 2 * 1 ft + 2 ft = 5 ft

Live load width at bottom of geofoam:

$L_{BG} = B + 2z_1 + z_2 + z_3$

L_{BG} = 1 ft + 2 * 1 ft + 2 ft + 6 ft = 11 ft

Note: Loads are shown calculated at top and bottom of geofoam only here for simplicity, but the load at any depth in geofoam can be calculated following a similar method.

Calculation – Live Loads

Live load at top of geofoam:

No load interaction so load = Q

$\sigma_{LL\ TG} = Q / (L_{TG\ TR} * L_{TG\ LO})$

$\sigma_{LL\ TG} = 12500\ lb / (5\ ft * 5\ ft) = 500\ lb/ft^2$

$\sigma_{LL\ TG} = (500\ lb/ft^2) / (144\ in^2/ft^2) = 3.47\ psi$

Live load at beginning of stress overlap depth of geofoam:

Two loads interact so load = 2Q

$\sigma_{LL\ BG} = 2Q / (L_{OD\ TR} * L_{OD\ LO})$

$\sigma_{LL\ BG} = 2 * 12500\ lb / (12\ ft * 6\ ft)/ = 347\ lb/ft^2$

$\sigma_{LL\ BG} = (347\ lb/ft^2) / (144\ in^2/ft^2) = 2.41\ psi$

Live load at bottom of geofoam:

$\sigma_{LL\ BG} = 2Q / (L_{BG\ TR} * L_{BG\ LO})$

$\sigma_{LL\ BG} = 2 * 12500\ lb / (17\ ft * 11\ ft) / = 134\ lb/ft^2$

$\sigma_{LL\ BG} = (134\ lb/ft^2) / (144\ in^2/ft^2) = 0.93\ psi$

Calculation – Total Dead Loads and Live Loads

Total load at top of geofoam:

$\sigma_{TL\ TG} = \sigma_{DL\ TG} + \sigma_{LL\ TG}$

$\sigma_{TL\ TG} = 425\ lb/ft^2 + 500\ lb/ft^2 = 925\ lb/ft^2$

$\sigma_{TL\ TG} = 2.95\ psi + 3.47\ psi = 6.42\ psi$

Total load at beginning of stress overlap depth of geofoam:

$\sigma_{TL\ ID} = \sigma_{DL\ ID} + \sigma_{LL\ ID}$

$\sigma_{TL\ ID} = 426\ lb/ft^2 + 347\ lb/ft^2 = 773\ lb/ft^2$

$\sigma_{TL\ ID} = 2.96\ psi + 2.41\ psi = 5.37\ psi$

Total load at bottom of geofoam:

$\sigma_{TL\ BG} = \sigma_{DL\ BG} + \sigma_{LL\ BG}$

$\sigma_{TL\ BG} = 433\ lb/ft^2 + 134\ lb/ft^2 = 567\ lb/ft^2$

$\sigma_{TL\ BG} = 3.01\ psi + 0.93\ psi = 3.94\ psi$

Maximum stress on Geofoam is 6.42 psi
EPS 22 with a compressive resistance at 1% strain of 7.3 psi is suitable.

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