R-SHIELD® GEOFOAM CALCULATION EXAMPLE 3

Introduction

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

R-Shield Geofoam is a structural material produced in compliance with ASTM D6817, “Standard Specification for Rigid Cellular Geofoam”. R-Shield 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 R-Shield 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 R-Shield 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. R-Shield EPS 22 Geofoam is proposed to be used. Vertical loads must be calculated to ensure R-Shield EPS 22 Geofoam is appropriate.

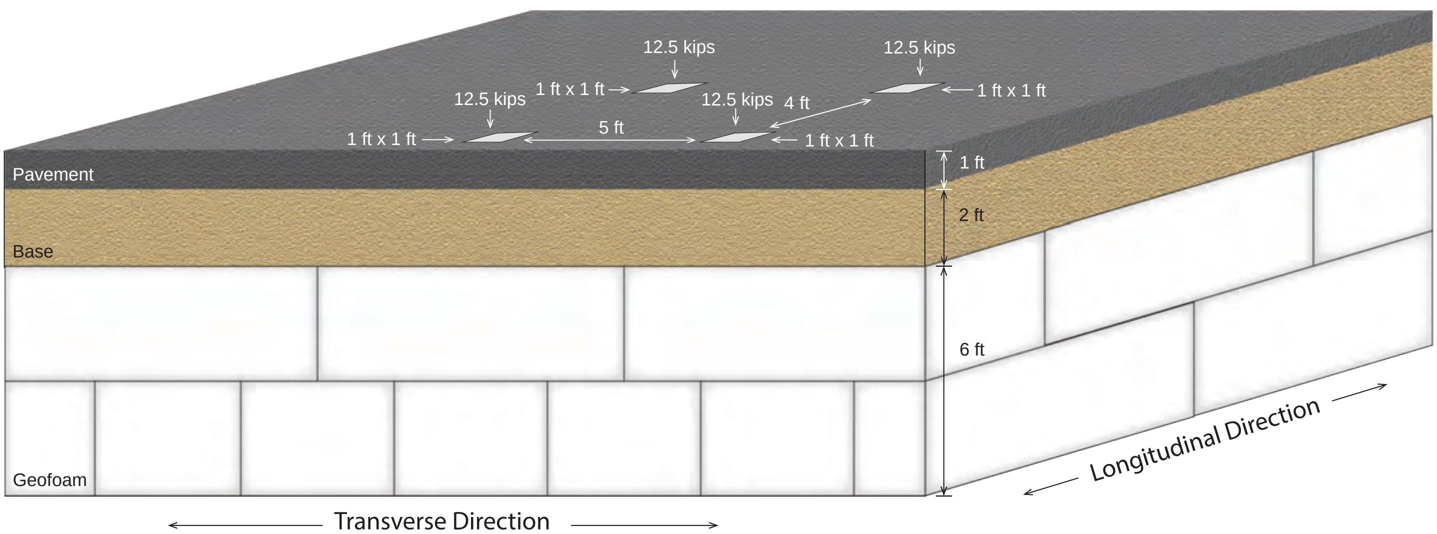

Figure 1. Project Section

Analysis Method

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

Load Distribution

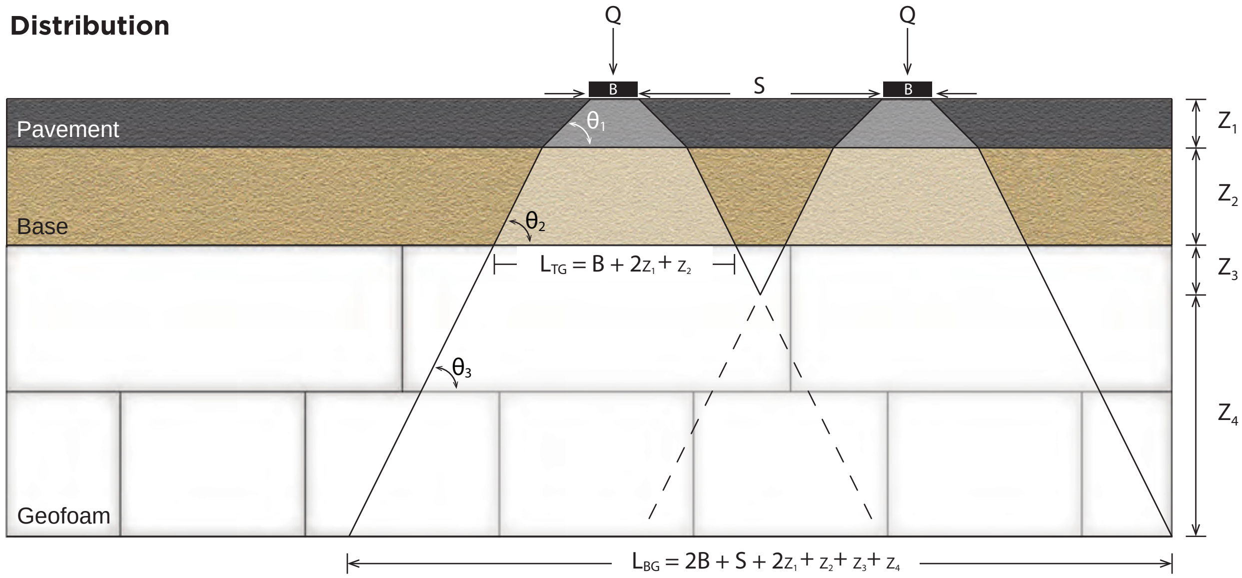

Figure 2. Simplified vertical stress distribution

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

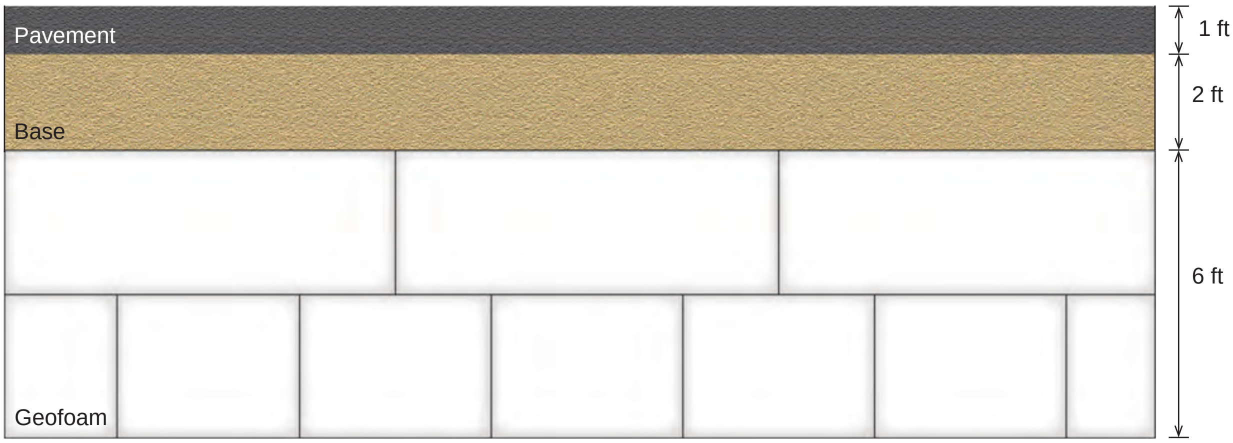

Figure 3. Calculations for dead loads

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 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

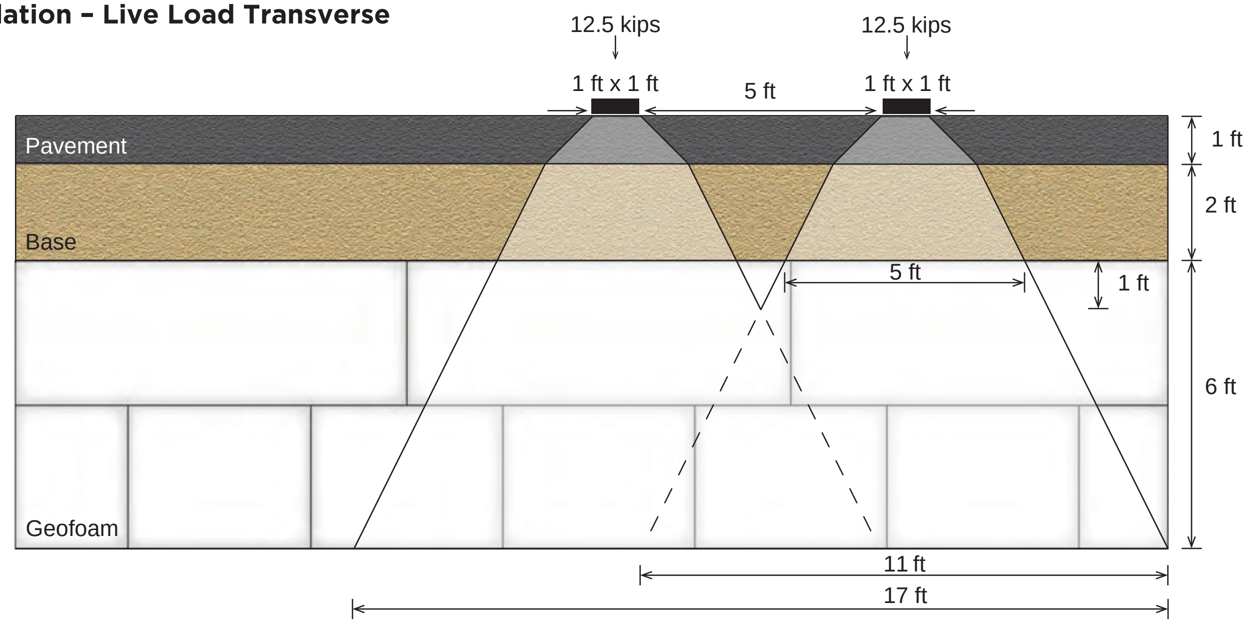

Figure 4. Calculations for live loads

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 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 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

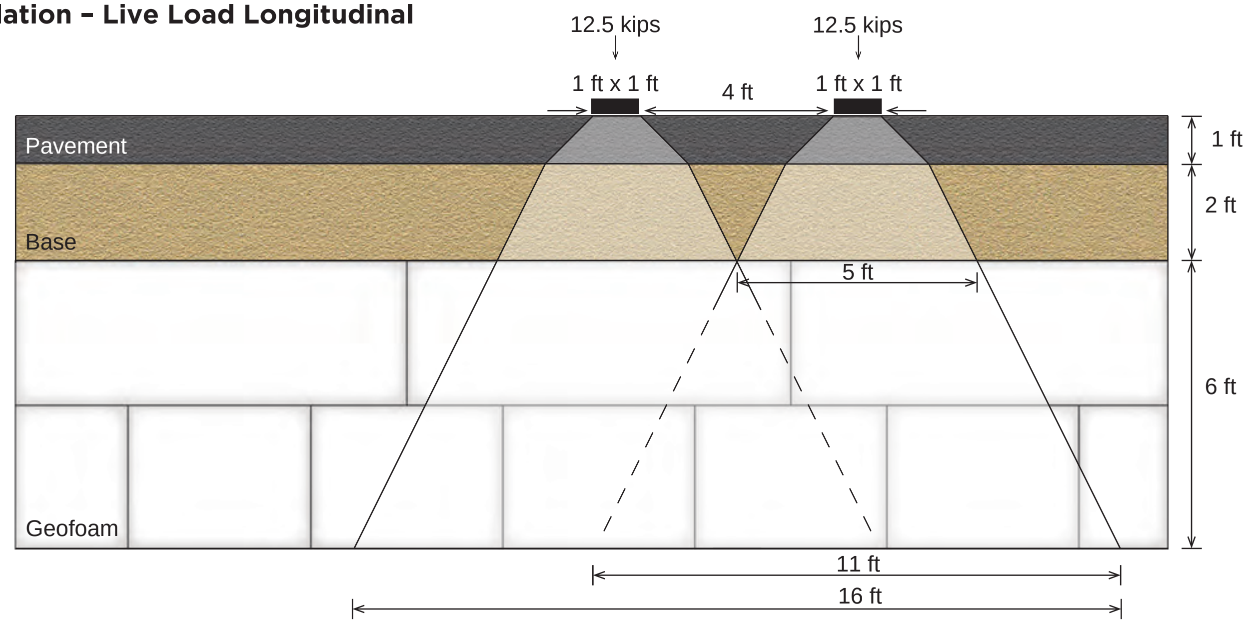

Figure 5. Calculations for live loads

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:

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

L_{BG} = 2 * 1 ft + 4 ft + 2 * 1 ft + 2 ft + 0 ft + 6 ft = 16ft

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 bottom of geofoam:

All four loads interact so load = 4Q

$\sigma_{LL\ BG} = 4Q / (L_{BG\ TR} * L_{BG\ LO})$

$\sigma_{LL\ BG} = 4 * 12500\ lb / (17\ ft * 16\ ft) / = 184\ lb/ft^2$

$\sigma_{LL\ BG} = (184\ lb/ft^2) / (144\ in^2/ft^2) = 1.28\ psi$

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 bottom of geofoam:

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

$\sigma_{TL\ BG} = 433\ lb/ft^2 + 184\ lb/ft^2 = 617\ lb/ft^2$

$\sigma_{TL\ BG} = 3.01\ psi + 1.28\ psi = 4.29\ psi$

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