

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.

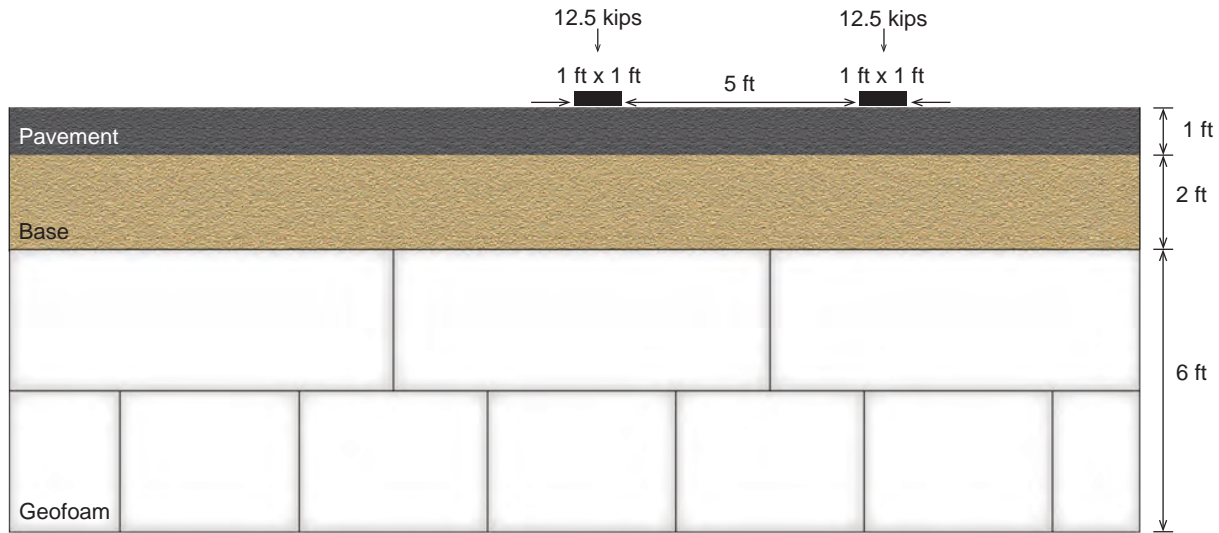


Figure 1. Project Section

Analysis Method

A simplified vertical stress distribution model is shown in Figure 2 and Figure 3 based on NCHRP published literature¹.

Transverse Load Distribution

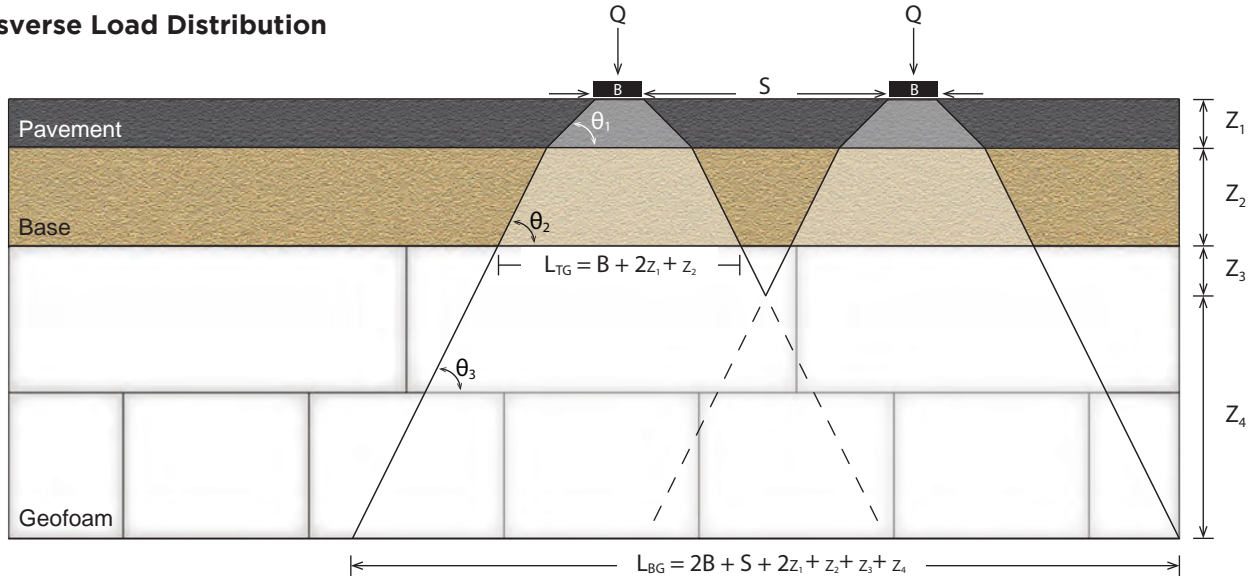


Figure 2. Simplified vertical stress distribution

Longitudinal Load Distribution

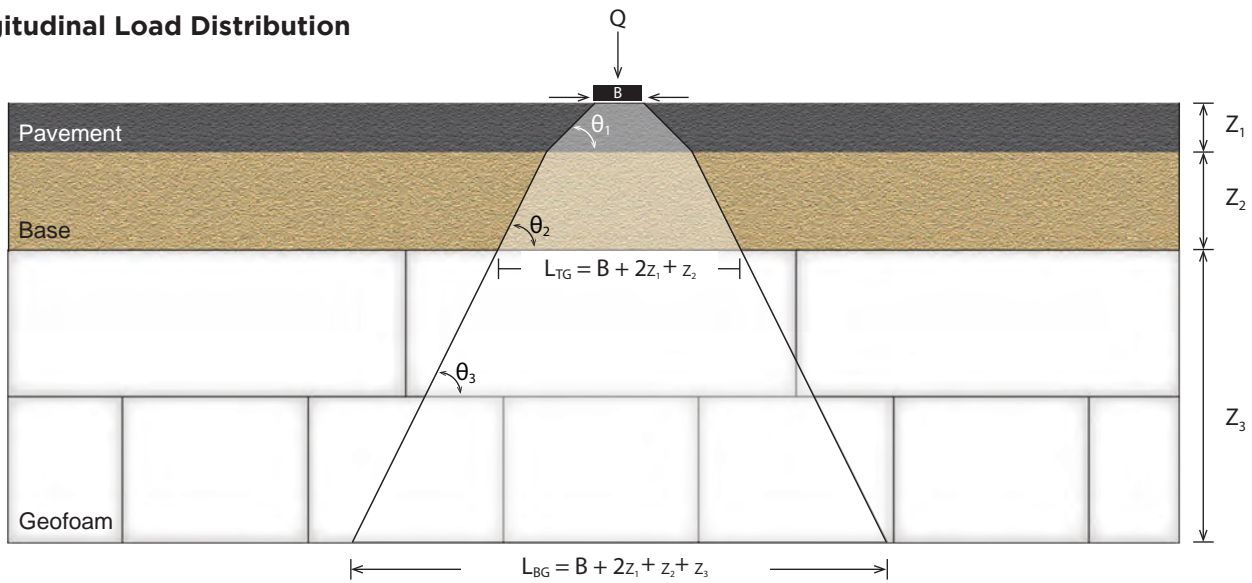


Figure 3. Simplified vertical stress distribution

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

¹NCHRP 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

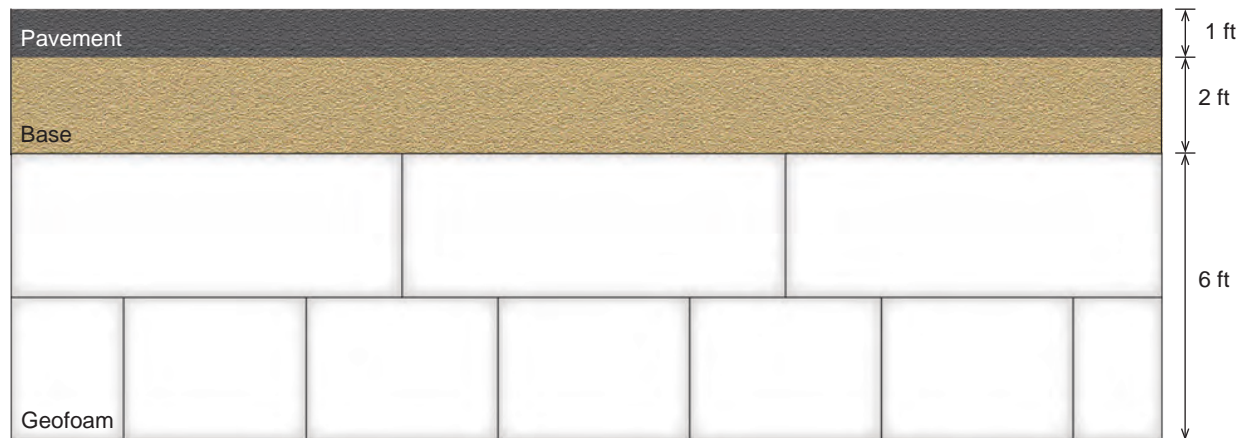


Figure 4. Calculations for dead loads

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

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

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

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

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

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

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

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

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

Calculation - Live Load Transverse

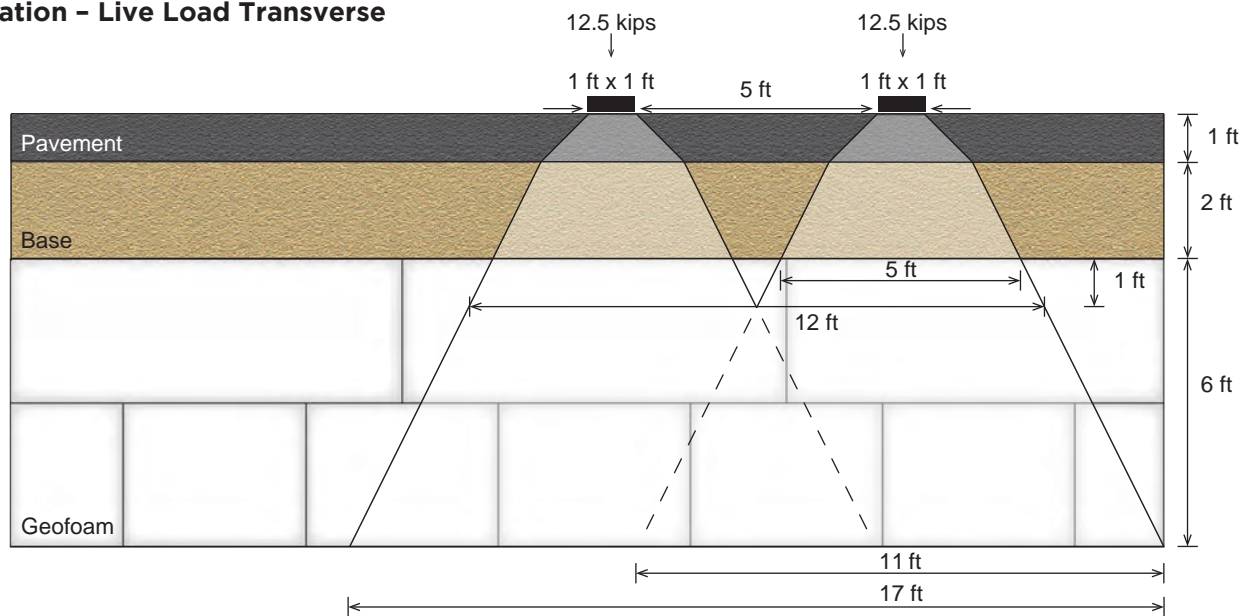


Figure 5. Calculations for live loads

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

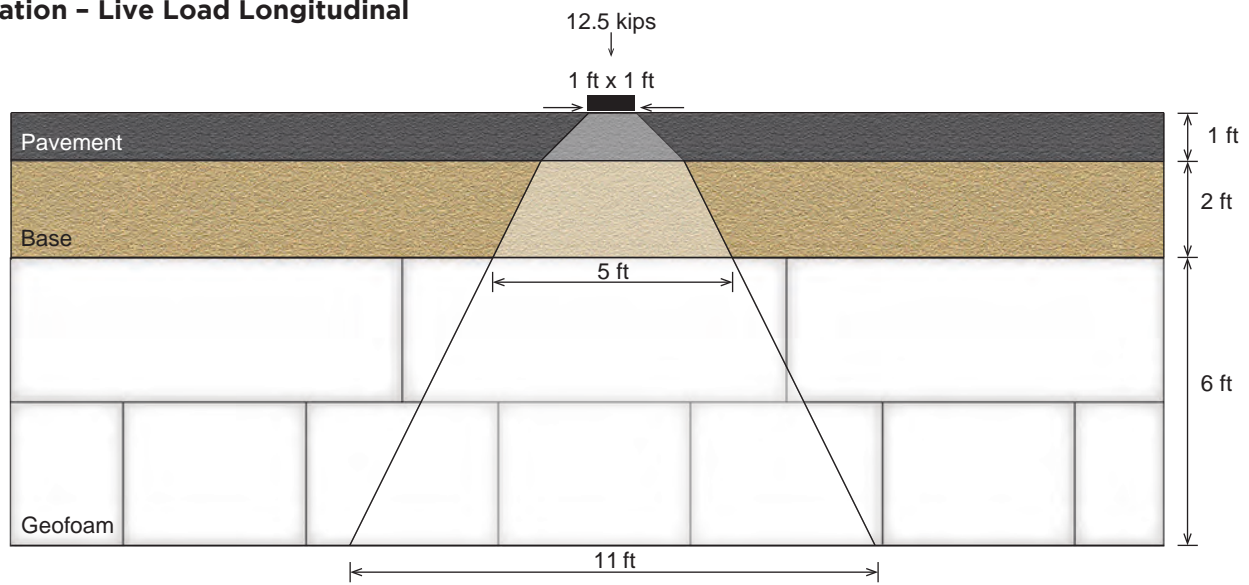


Figure 6. Calculations for live loads

Live load width at top of geofoam:

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

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

Live load width at bottom of geofoam:

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

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

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 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.