Introduction

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

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

![Figure 1. Project Section](image)
**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

![Transverse Load Distribution Diagram](image)

**Figure 2. Simplified vertical stress distribution**

### Longitudinal Load Distribution

![Longitudinal Load Distribution Diagram](image)

**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
- **\( \theta_1 \)** = 1H:1V slope
- **\( \theta_2 \)** = 1H:2V slope
- **\( \theta_3 \)** = 1H:2V slope
- **\( z_1 \)** = thickness of pavement
- **\( z_2 \)** = thickness of road base
- **\( z_3 \)** = depth within geofoam
- **\( z_4 \)** = depth within geofoam

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\(^{1}\)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

Dead load at top of geofoam:

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

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

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

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

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

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

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

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

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

Dead load at bottom of geofoam:

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

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

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

$$\sigma_{DL \ BG} = \frac{433 \text{ lbs/ft}^2}{144 \text{ in}^2/\text{ft}^2} = 3.01 \text{ psi}$$
Calculation – Live Load Transverse

Live load width at top of geofoam:
\[ L_{TG} = B + 2Z_1 + Z_2 \]
\[ L_{TG} = 1\text{ ft} + 2 \times 1\text{ ft} + 2\text{ ft} = 5\text{ ft} \]

Live load width at beginning of overlap depth of vertical stress distributions from 2 transverse surface loads
\[ L_{OD} = 2B + S + 2Z_1 + Z_2 + Z_3 \]
\[ L_{OD} = 2 \times 1\text{ ft} + 5\text{ ft} + 2 \times 1\text{ ft} + 2\text{ ft} + 1\text{ ft} = 12\text{ ft} \]

Live load width at bottom of geofoam:
\[ L_{BG} = 2B + S + 2Z_1 + Z_2 + Z_3 + Z_4 \]
\[ L_{BG} = 2 \times 1\text{ ft} + 5\text{ ft} + 2 \times 1\text{ ft} + 2\text{ ft} + 1\text{ ft} + 5\text{ ft} = 17\text{ ft} \]

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.
Figure 6. Calculations for live loads

Live load width at top of geofoam:

\[ L_{TG} = B + 2z_1 + z_2 \]

\[ L_{TG} = 1 \text{ ft} + 2 \times 1 \text{ ft} + 2 \text{ ft} = 5 \text{ ft} \]

Live load width at bottom of geofoam:

\[ L_{BG} = B + 2z_1 + z_2 + z_3 \]

\[ L_{BG} = 1 \text{ ft} + 2 \times 1 \text{ ft} + 2 \text{ ft} + 6 \text{ ft} = 11 \text{ ft} \]

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
\[ \sigma_{LL\ TG} = Q / (L_{TG\ TR} \cdot L_{TG\ LO}) \]
\[ \sigma_{LL\ TG} = 12500 \text{ lb} / (5 \text{ ft} \cdot 5 \text{ ft}) = 500 \text{ lb/ft}^2 \]
\[ \sigma_{LL\ TG} = (500 \text{ lb/ft}^2) / (144 \text{ in}^2/\text{ft}^2) = 3.47 \text{ psi} \]

Live load at beginning of stress overlap depth of geofoam:
Two loads interact so load = 2Q
\[ \sigma_{LL\ BG} = 2Q / (L_{OD\ TR} \cdot L_{OD\ LO}) \]
\[ \sigma_{LL\ BG} = 2 \cdot 12500 \text{ lb} / (12 \text{ ft} \cdot 6 \text{ ft}) = 347 \text{ lb/ft}^2 \]
\[ \sigma_{LL\ BG} = (347 \text{ lb/ft}^2) / (144 \text{ in}^2/\text{ft}^2) = 2.41 \text{ psi} \]

Live load at bottom of geofoam:
\[ \sigma_{LL\ BG} = 2Q / (L_{BG\ TR} \cdot L_{BG\ LO}) \]
\[ \sigma_{LL\ BG} = 2 \cdot 12500 \text{ lb} / (17 \text{ ft} \cdot 11 \text{ ft}) = 134 \text{ lb/ft}^2 \]
\[ \sigma_{LL\ BG} = (134 \text{ lb/ft}^2) / (144 \text{ in}^2/\text{ft}^2) = 0.93 \text{ psi} \]

Calculation – Total Dead Loads and Live Loads

Total load at top of geofoam:
\[ \sigma_{TL\ TG} = \sigma_{DL\ TG} + \sigma_{LL\ TG} \]
\[ \sigma_{TL\ TG} = 425 \text{ lb/ft}^2 + 500 \text{ lb/ft}^2 = 925 \text{ lb/ft}^2 \]
\[ \sigma_{TL\ TG} = 2.95 \text{ psi} + 3.47 \text{ psi} = 6.42 \text{ psi} \]

Total load at beginning of stress overlap depth of geofoam:
\[ \sigma_{TL\ ID} = \sigma_{DL\ ID} + \sigma_{LL\ ID} \]
\[ \sigma_{TL\ ID} = 426 \text{ lb/ft}^2 + 347 \text{ lb/ft}^2 = 773 \text{ lb/ft}^2 \]
\[ \sigma_{TL\ ID} = 2.96 \text{ psi} + 2.41 \text{ psi} = 5.37 \text{ psi} \]

Total load at bottom of geofoam:
\[ \sigma_{TL\ BG} = \sigma_{DL\ BG} + \sigma_{LL\ BG} \]
\[ \sigma_{TL\ BG} = 433 \text{ lb/ft}^2 + 134 \text{ lb/ft}^2 = 567 \text{ lb/ft}^2 \]
\[ \sigma_{TL\ BG} = 3.01 \text{ psi} + 0.93 \text{ psi} = 3.94 \text{ psi} \]

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