

Product Information Bulletin

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GeoSpec® Lightweight Fill Construction Principles

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GeoSpec® lightweight fill material is expanded polystyrene (EPS) geofoam used in ground fill applications where a lightweight fill material is required to reduce stresses on underlying or adjoining soils/structures. EPS geofoam has been used in projects involving roads, bridge approach fills, embankments, levees, berms, foundations, landscaping, etc., worldwide for over 50 years.

GeoSpec fill material can be designed to support high compressive loads, but has a density less than 1% of traditional earth materials. ASTM D6817, **Standard Specification for Rigid Cellular Polystyrene Geofoam**, includes specifications for a density range of 11 kg/m³ (0.7 pcf) to 46 kg/m³ (2.85 pcf) providing EPS geofoam types with compressive resistance properties that can meet a wide range of geotechnical engineering specifications. The required GeoSpec fill material type should be specified based upon the compressive resistance¹ required for a specific project.

Material Property ²	Units	D6817 GeoSpec Type Designations ³						
		EPS12	EPS15	EPS19	EPS22	EPS29	EPS39	EPS46
Product Density <i>Minimum</i> ASTM C303	kg/m ³ (pcf)	11.2 (0.70)	14.4 (0.90)	18.4 (1.15)	21.6 (1.35)	28.8 (1.80)	38.4 (2.40)	45.7 (2.85)
Compressive Resistance <i>Minimum @ 1% Strain</i> ASTM D1621	kPa (psi)	15 (2.2)	25 (3.6)	40 (5.8)	50 (7.3)	75 (10.9)	103 (15.0)	128 (18.6)
Flexural Strength <i>Minimum</i> ASTM C203	kPa (psi)	69 (10)	172 (25)	207 (30)	240 (35)	345 (50)	414 (60)	517 (75)
Limiting Oxygen Index <i>Minimum</i> ASTM D2863	%	24	24	24	24	24	24	24
Additional Compressive Resistance Properties ⁴								
Compressive Resistance <i>Minimum @ 5% Strain</i> ASTM D1621	kPa (psi)	35 (5.1)	55 (8.0)	90 (13.1)	115 (16.7)	170 (25.0)	241 (35.0)	300 (43.5)
Compressive Resistance <i>Minimum @ 10% Strain</i> ASTM D1621	kPa (psi)	40 (5.8)	70 (10.2)	110 (16.0)	135 (19.6)	200 (29.0)	276 (40.0)	345 (50.0)

1. Compressive resistance at 1% strain is within the elastic limit for the GeoSpec types in the above table and is accepted as the design compressive resistance to limit long-term deformation under structural load.
2. GeoSpec lightweight fill material properties are third party certified under a certification program administered by Intertek based upon ASTM D7557, **Standard Practice for Sampling of Expanded Polystyrene Geofoam Specimens**.
3. The material properties for GeoSpec lightweight fill material are third party certified by Intertek.
4. Compressive resistance at 5% and 10% strain in the above table are provided for applications where the intended end-use requires long-term deformation under structural load – i.e., a compressible product.

GeoSpec fill material offers the following benefits to maximize onsite installation efficiency:

- Material arrives ready to place, no weather delays.
- Material can be prefabricated or cut at the jobsite, no staging required.
- Material can be inventoried, improving production efficiency.
- Lightweight product, easy to handle.

GeoSpec Construction Principles

The following information identifies key issues in each step in the construction process that will need to be addressed in order to ensure a quality GeoSpec fill material installation. However, the information is provided for general reference only and is not intended to override project specifications prepared applicable to a specific product application.

The steps are addressed are as follows:

- Site Preparation
- Block Shipment, Handling and On-Site Storage
- Combustibility and Protection Against Hydrocarbon Spills
- Block Layout and Placement
- Pavement Construction

Site Preparation:

Ideally, the bottom of the first layer of GeoSpec fill material block should be placed above the mean height of the water table, where possible. Any water at or near the ground surface must be pumped off until the GeoSpec fill material block is covered by material whose weight is sufficient to prevent flotation.

The bottom layer of GeoSpec fill material block must be supported over its entire lower face, so a plane surface, inclined as appropriate, must be prepared. Departures from planarity may not exceed ± 10 mm in 3 meters (3/8" in 10 feet). The levelling material used is generally sand; its thickness depends on the ground and the machines to be employed.

Once GeoSpec fill material blocks are in place, they should be covered as soon as possible. Suitable drainage measures must be taken. On sloping sites this is particularly important. If there is any possibility of flooding, buoyancy effects must be considered.

For buoyancy calculations, GeoSpec fill material density may be taken as no more than the dry density of the product, but for load calculations the density of material with moisture content must be assumed. Using the appropriate calculation methods, the designer must confirm that the road system – including earthworks and the supported structures – is stable with respect to shear due to differential settlement, slip, and flotation.

Conditions while the system is under construction must also be taken into account and the designer must assume the most unfavourable conditions. Any water at or near the ground surface must be pumped off until the GeoSpec fill material block is covered by material whose weight is sufficient to prevent flotation. Once GeoSpec fill material blocks are in place, they should be covered as soon as possible. Suitable drainage measures must also be taken during construction. On sloping sites this is particularly important.

Block Shipment, Handling and On-Site Storage

The types of trucks used to deliver to site (e.g., closed van or flat bed trailers), the loading of the trailers and the sequencing of delivery must be coordinated with Plasti-Fab well in advance of delivery. Typically, GeoSpec fill material is delivered in trailer load quantity. The blocks are not normally packaged – i.e., plastic is wrap not provided. If on-site storage for a period of time is anticipated the blocks should be covered with an opaque material.

Damage can occur during shipment and handling on site. Damage which occurs during delivery should be identified to Plasti-Fab personnel immediately.

At all stages of construction, GeoSpec fill material should be handled in such a manner so as to minimize possible damage to blocks. GeoSpec fill material should be positioned at the work site using the appropriate method to avoid damage. Lifting or transporting blocks in any manner that creates dents, holes or broken edges should be avoided.

If GeoSpec fill material blocks are to be stockpiled on site until placement, a secure storage area should be designated for this purpose. No traffic on the geofoam blocks should be permitted, especially vehicles or on-site equipment. The blocks should be stored away from any heat source or construction activity produces heat or open flame. GeoSpec fill material blocks stored on site should be secured with sand bags or similar "soft" weights to prevent their being dislodged by wind.

Combustibility and Protection Against Hydrocarbon Spills

GeoSpec lightweight fill material contains a flame-retardant additive. However, it may ignite when exposed to open flame or welding activities that are not part of the construction activities. Therefore, until the GeoSpec fill material block has been completely covered – e.g., non-combustible aggregate cover material – smoking and the use of any tools that may create an open flame in the proximity of GeoSpec fill material should be forbidden.

GeoSpec lightweight fill is not resistant to hydrocarbons. If danger of a hydrocarbon spill exists, designers should consider the use of a geomembrane resistant to hydrocarbons.

Block Layout and Placement

The block layout shall be designed so that the following general design details are taken into account:

- The plane on which a given layer of blocks is placed must be parallel to the road surface in a direction parallel to the longitudinal axis of the road alignment.
- There must be a minimum of two layers of blocks at all locations except where a layer of blocks terminates horizontally there may be a portion of the final block in that layer that has no EPS block above or below it.
- Within a given layer of blocks, the vertical joints between the adjacent ends of blocks within a given row of blocks ("row" is defined herein as a series of blocks placed end to end) should be offset horizontally to the greatest extent practicable relative to blocks in adjacent rows.
- The longitudinal axes of blocks for layers above and/or below a given layer must be oriented perpendicular to the longitudinal axes of blocks within that given layer.
- The longitudinal axes of the uppermost layer of blocks must be oriented perpendicular to the longitudinal axis of the road alignment.
- When GeoSpec fill material blocks must be cut to fit to complete a layer – custom cutting is completed on site – the cut blocks are to be located on the interior of the layers.
- Standard block sizes shall be as shown on GeoSpec block layout which has been developed with the overall objective to create a layout of blocks that is geometrically interlocked to the greatest extent possible.
- If it is necessary to cut block on site, the most precise method of cutting can be done using a portable hot-wire device that Plasti-Fab can provide assistance in assembling. Other methods of cutting include use of a wire saw or chain saw.

Limited study of interface friction between geofoam to geofoam as well as geofoam to other commonly used construction materials indicates that anchorage between geofoam blocks may be redundant due to geofoam interface friction angles and vertical loads on blocks from the completed structure above.

The table below provides some examples of published values for interface friction angles.

Interface	Peak Factor	Residual Factor
Foam-Foam, 20 kg/m ³ (dry)	0.85	0.70
Foam-Foam, 30 kg/m ³ (dry)	0.85	0.65
Foam-Cast in Place Concrete	2.36	1.00
Foam-Textured HDPE Membrane	1.00	~1.00
Foam-Smooth HDPE Membrane	0.29	0.23
Foam-Smooth PVC Membrane	0.70	0.40

If the calculated resistance forces along the normally horizontal surfaces between layers of GeoSpec fill material blocks are insufficient to resist horizontal driving or imposed forces, additional resistance between blocks is required to supplement the interface friction. When needed, Plasti-Fab recommends the use of barbed gripper plates at the rate of two fasteners per geofoam block in order to prevent movement during the construction process.

Pavement Construction

In general, pavement construction can occur in a normal manner with only a few cautions related to the use of GeoSpec fill material. The most critical step in the process is the placement and compaction of the first layer of soil above the GeoSpec fill material.

As a rule, the subgrade of the road distributes the load on and protects GeoSpec fill material block, while its surface constitutes the road formation. During construction, loads imposed by traffic may not exceed limits set according to the thickness of material over the GeoSpec fill material block. Vehicles and construction equipment, such as earth moving equipment, must not be operated directly on the surface of blocks.

It is also suggested that vibratory compaction equipment not be used within 508 mm (20 inches) vertically from the top surface of blocks. It has been found that plate vibratory has been the most suitable for compaction of unbound material in the pavement system.

Alternatively, loads can be spread through a 127 to 152 mm (5 to 6 inch) thick reinforced concrete slab formed in situ on the top surface of the GeoSpec geofoam. However, compacted layers of gravel materials may be used instead to provide required load distribution. But in any case, traffic in direct contact with the GeoSpec lightweight fill material block is not permissible and loads imposed must not exceed design compressive load characteristics of the GeoSpec fill material.

For additional technical information applicable to construction using GeoSpec fill material, contact your Plasti-Fab Technical Sales Representative.