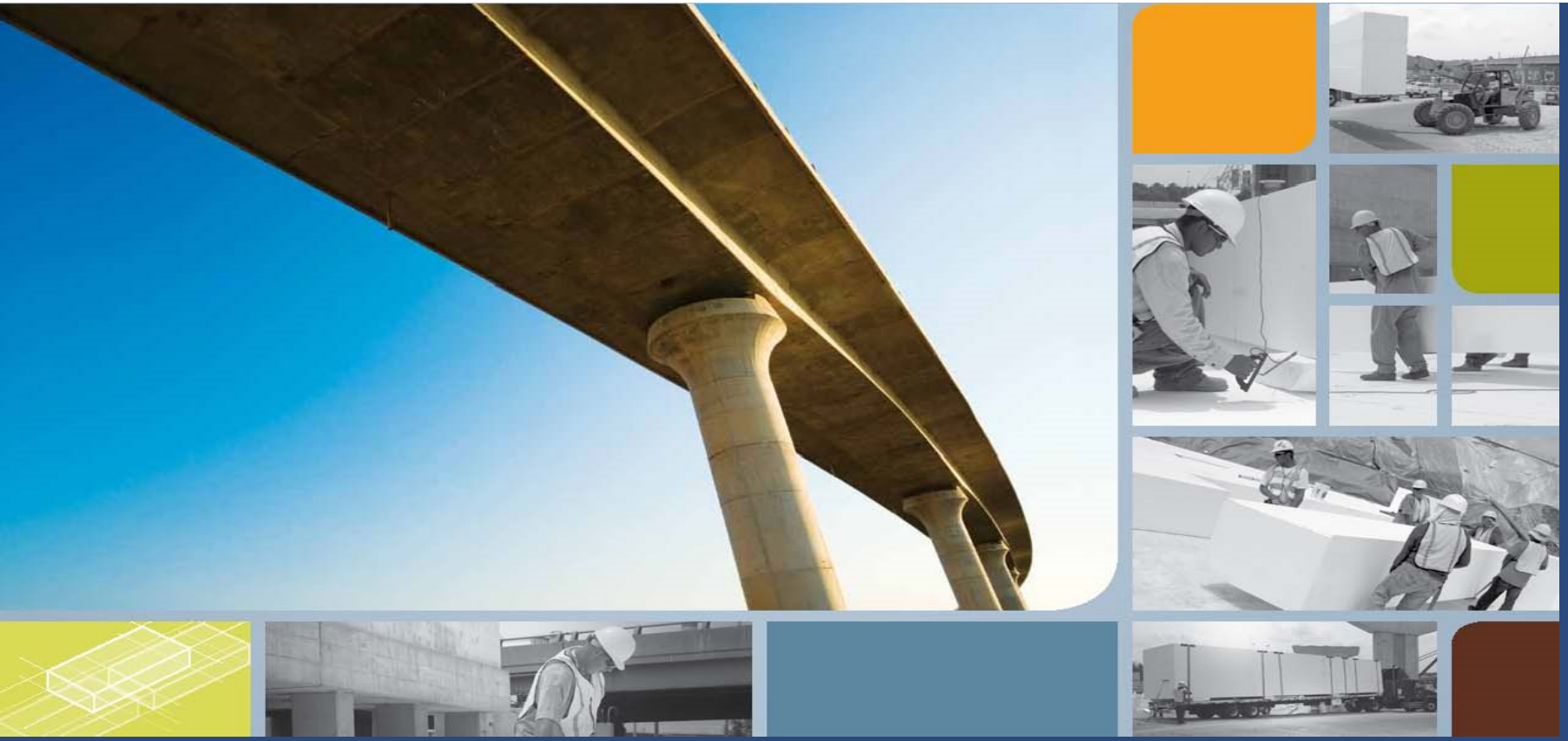

Expanded Polystyrene (EPS) Geofoam Applications & Technical Data

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Geofoam Civil Engineering

EPS Geofoam

- Expanded polystyrene (EPS) geofoam used as geotechnical material since the 1960s.
- Solves engineering challenges.
- Lightweight.
  - Approximately 1% the weight of soil.
  - Less than 10% weight of other lightweight fill alternatives.
- Reduces loads imposed on adjacent and underlying soil & structures.

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Geofoam Civil Engineering

EPS Geofoam Benefits

- Accelerates project schedules.
- Easy to handle.
- Unaffected by weather conditions.
- Can be cut & shaped onsite.
- Retains physical properties under engineered condition of use.
- Arrives onsite having undergone rigorous QA/QC testing.

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EPS Geofoam Applications & Use

- Road construction over poor soils
- Road widening
- Bridge abutment
- Bridge underfill
- Culverts, pipes & buried structures
- Compensating foundation
- Rail embankment
- Landscaping & vegetative green roofs
- Retaining & buried wall backfill
- Slope stabilization
- Stadium & theatre seating
- Levees
- Airport runway/taxiway
- Foundations for lightweight structures
- Noise & vibration damping
- Compressible application
- Seismic application
- Permafrost embankments
- Rockfall/impact protection

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ASTM EPS Geofoam Standards

EPS geofoam is available in different material types.

Thorough knowledge & understanding of the material type being used on an EPS geofoam project is essential.

- **ASTM D6817** Standard Specification for Rigid Cellular Polystyrene Geofoam
  - Physical properties & dimensions of EPS geofoam.
- **ASTM D7180** Standard Guide for the Use of EPS Geofoam in Geotechnical Projects
  - Design considerations for EPS geofoam.
- **ASTM D7557** Standard Practice for Sampling of EPS Geofoam Specimens
  - Quality assurance.

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EPS geofoam specification

ASTM D6817 Physical Property Requirements of EPS Geofoam

Type	EPS12	EPS15	EPS19	EPS22	EPS29	EPS39	EPS46
Density, min., kg/m^3(lb/ft^3)	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, min., kPa (psi) at 1 %	15 (2.2)	25 (3.6)	40 (5.8)	50 (7.3)	75 (10.9)	103 (15.0)	128 (18.6)
Compressive Resistance, min., kPa (psi) at 5 %	35 (5.1)	55 (8.0)	90 (13.1)	115 (16.7)	170 (24.7)	241 (35.0)	300 (43.5)
Compressive Resistance, min., kPa (psi) at 10 %[A]	40 (5.8)	70 (10.2)	110 (16.0)	135 (19.6)	200 (29.0)	276 (40.0)	345 (50.0)
Flexural Strength, min., kPa (psi)	69 (10.0)	172 (25.0)	207 (30.0)	240 (35.0)	345 (50.0)	414 (60.0)	517 (75.0)
Oxygen index, min., volume %	24.0	24.0	24.0	24.0	24.0	24.0	24.0

The typical design load limit for EPS Geofoam is the compressive resistance at 1%. Please refer to section 4.2 for additional information.

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EPS geofoam applications

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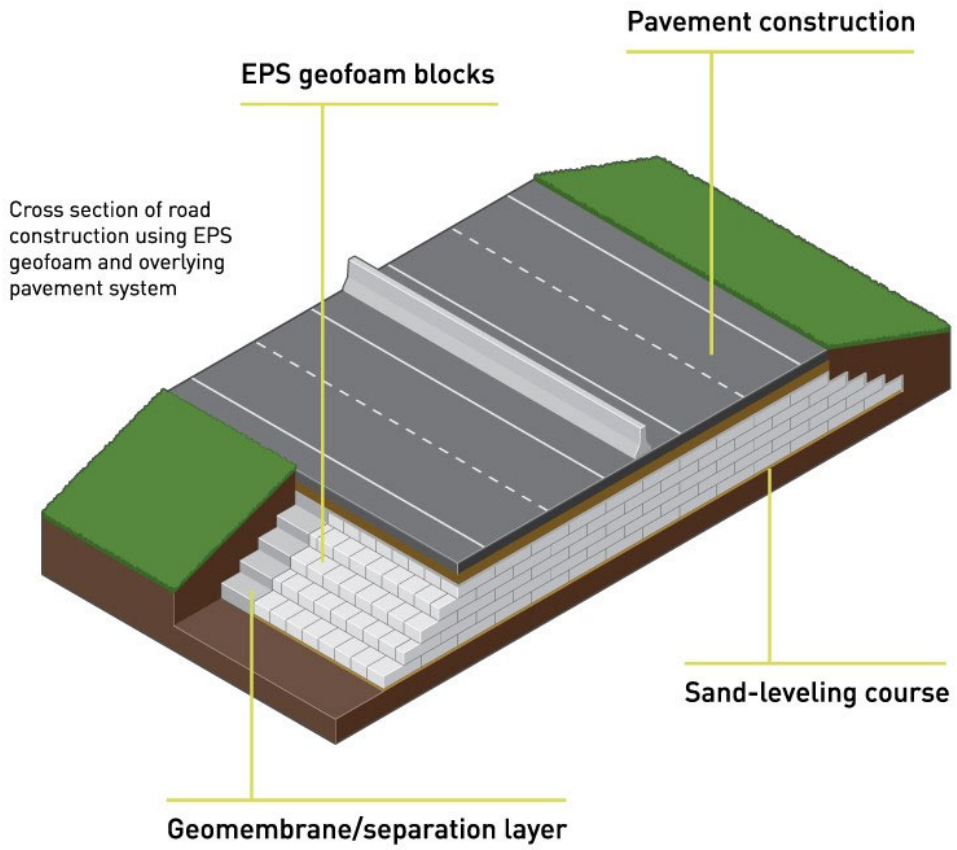
Road construction over poor soils

- Replaces compressible, soft soils or heavy fill materials.
- Prevents unacceptable loading on underlying soils and adjacent structures.
- High compressive strength supports interstate traffic loadings.



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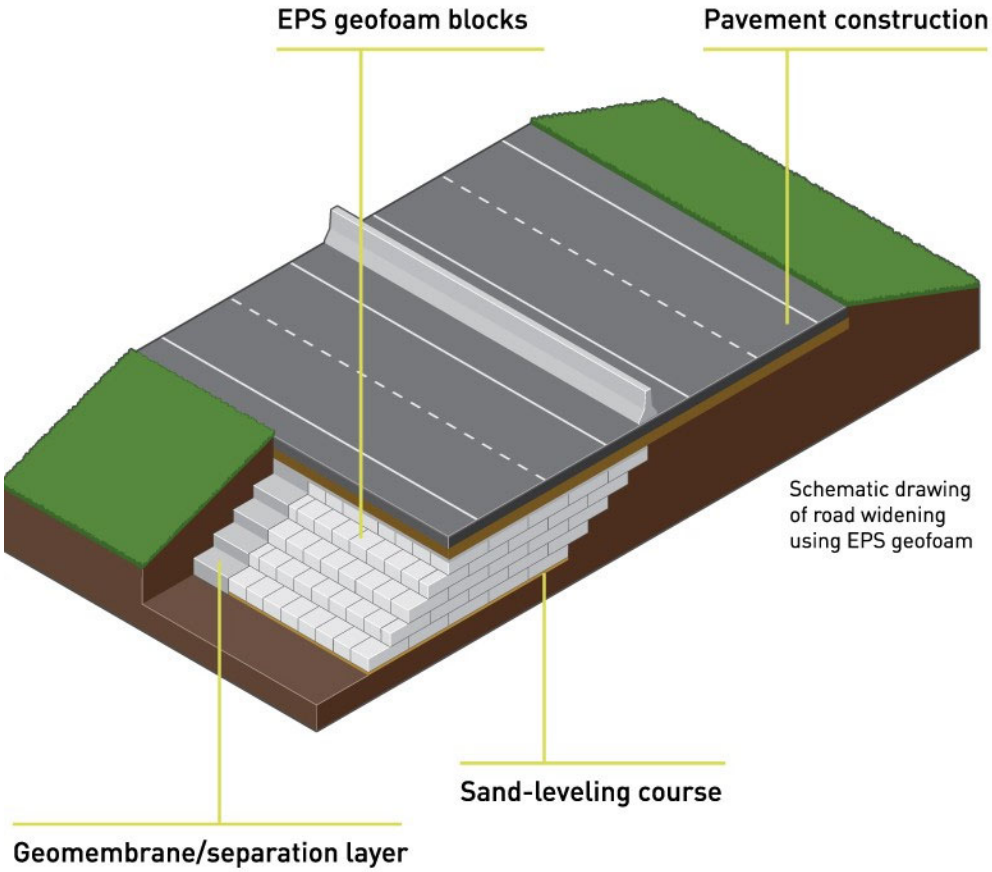
Road widening

- Eliminates need for compaction & fill testing.
- Minimizes impact to existing roadway, adjacent structures & buried utilities.
- Withstands traffic forces.
- Reduces construction time.



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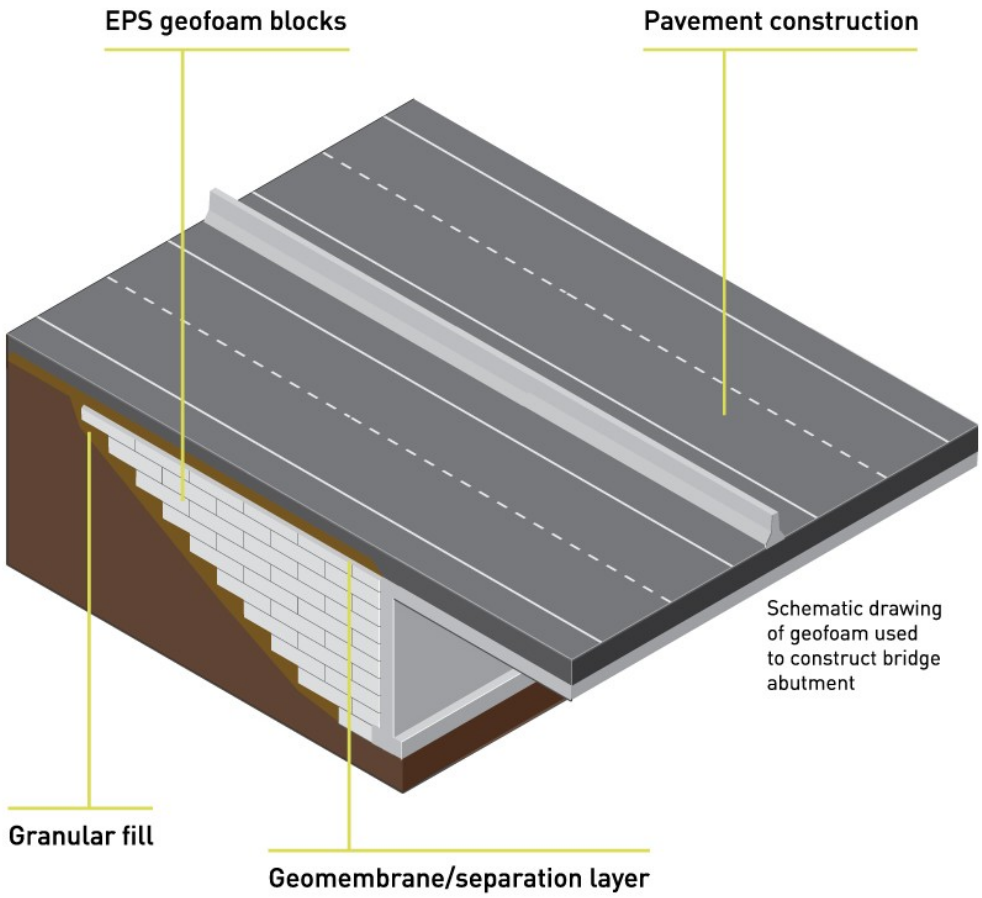
Bridge abutment

- Safely supports highway loading without over-stressing underlying soils.
- Less differential movement at bridge/approach.
  - Reduces cost of approach slab.
  - Reduces long term maintenance.
- Reduces lateral forces on abutment walls, foundations & other retaining structures.
  - Savings in design of bridge abutment & other walls.



Schematic drawing of geofoam used to construct bridge abutment

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Geofoam Civil Engineering

Bridge underfill

- Adds minimal load to underlying ground.
- Helps support bridge span & transfer traffic load safely to foundation or underlying soil.

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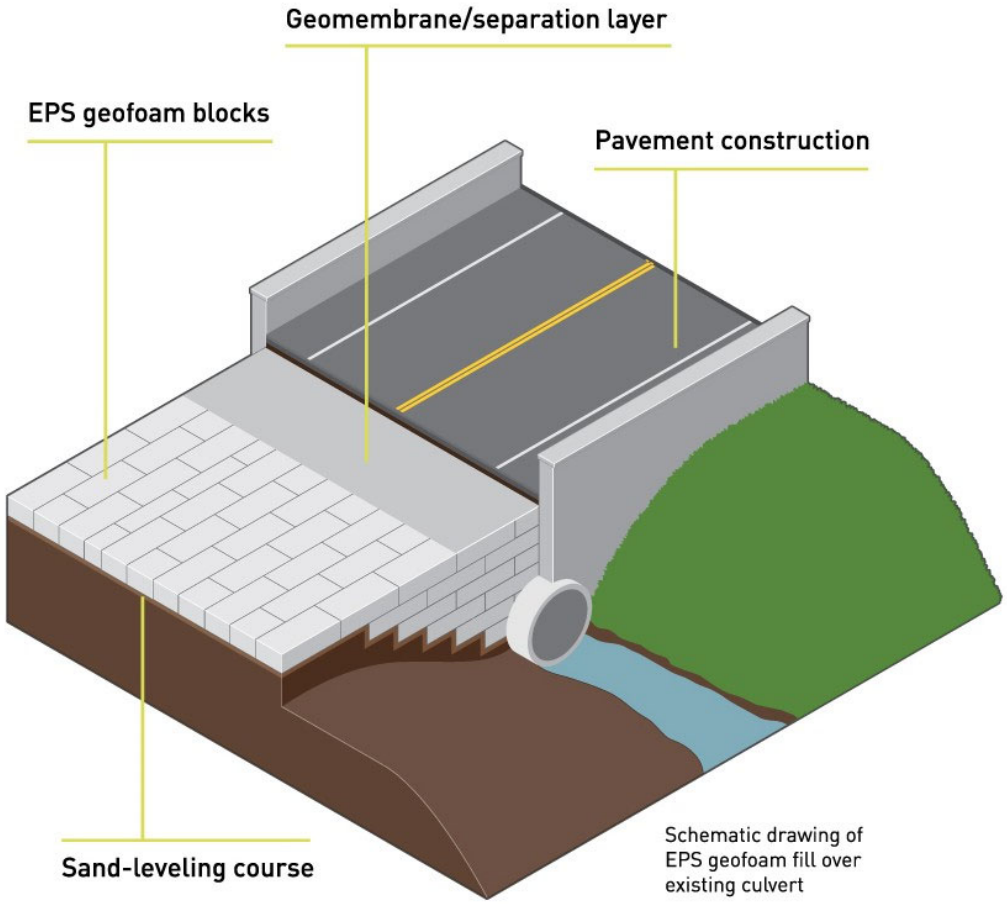
Culverts, pipelines & buried structures

- Used in lieu of heavier traditional fills over structures that were not designed to support increased loads.
- Eliminates the need for removal or strengthening of existing underground structures.



Schematic drawing of EPS geofoam fill over existing culvert

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Compensating foundation

- Reduces load on underlying compressible soils.
- Minimizes building settlement & potential bearing capacity problems.

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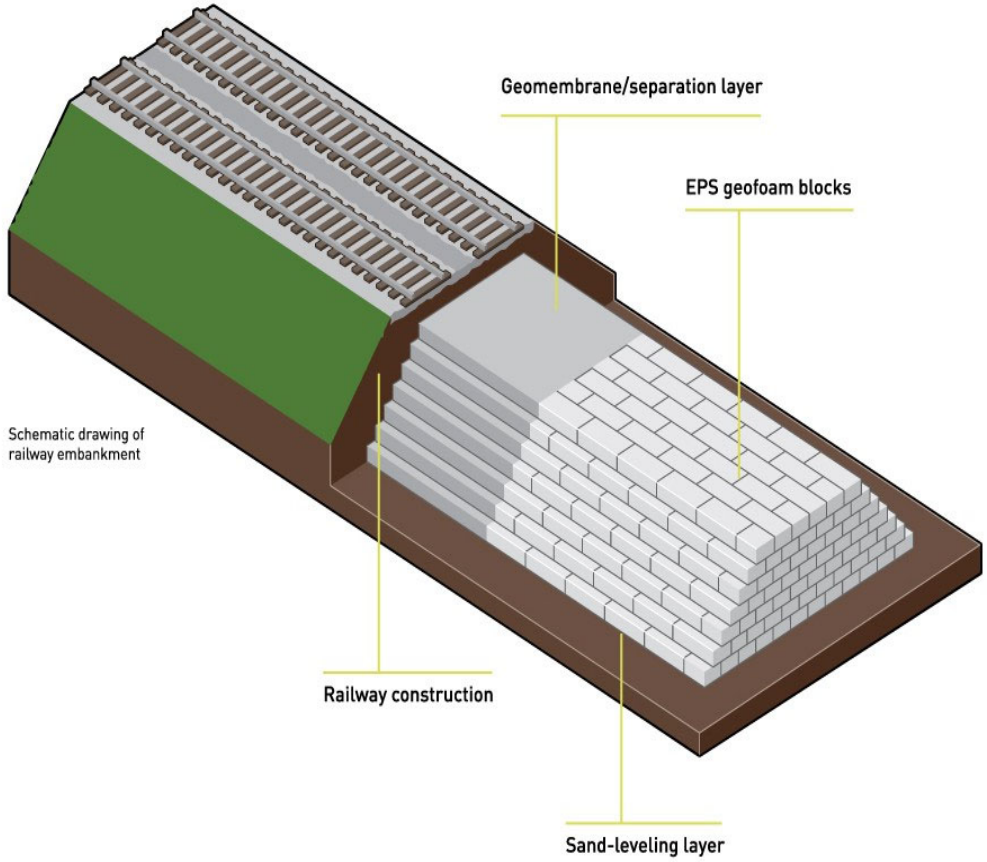
Rail embankment

- Strong enough to support railway loads.
- Does not overload existing soils.
- Prevents settlement of adjacent structures & utilities.



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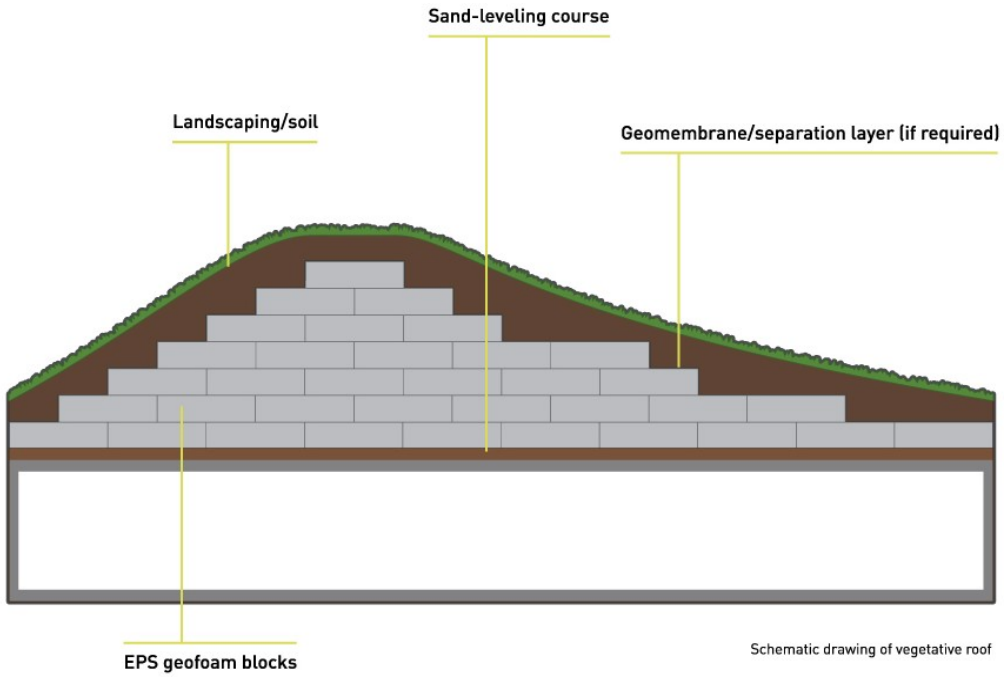
Landscaping & vegetative green roofs

- Vegetative roof benefits.
  - Reduce rainwater runoff.
  - Improve air quality.
  - Reduce air temperatures.
- Can be cut/trimmed onsite to fit odd geometries.
- Installed without special equipment.
- Does not add any appreciable load to roof structure.
- Provides insulation value.



Schematic drawing of vegetative roof

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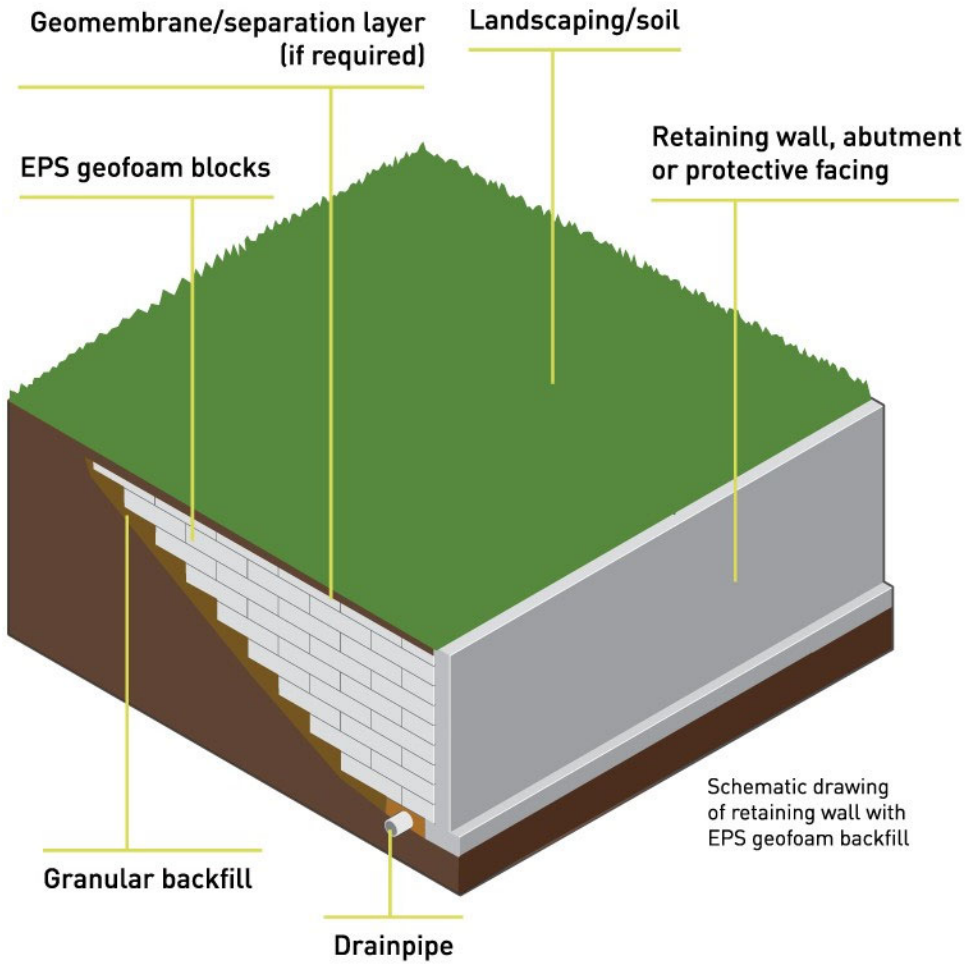
Retaining & buried wall backfill

- Reduces lateral pressures on structure.
- Limits horizontal forces that can develop during earthquakes.



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Slope stabilization

- Stabilizes & repairs soil & rock slopes.
- Replaces portion of existing soil.
  - Entire mass slide may not need to be excavated & replaced.
  - Significant time & cost savings.

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Stadium & theatre seating

- Tiered seating for auditoriums, movie theatres, gymnasiums & churches.
- New construction & renovation projects.

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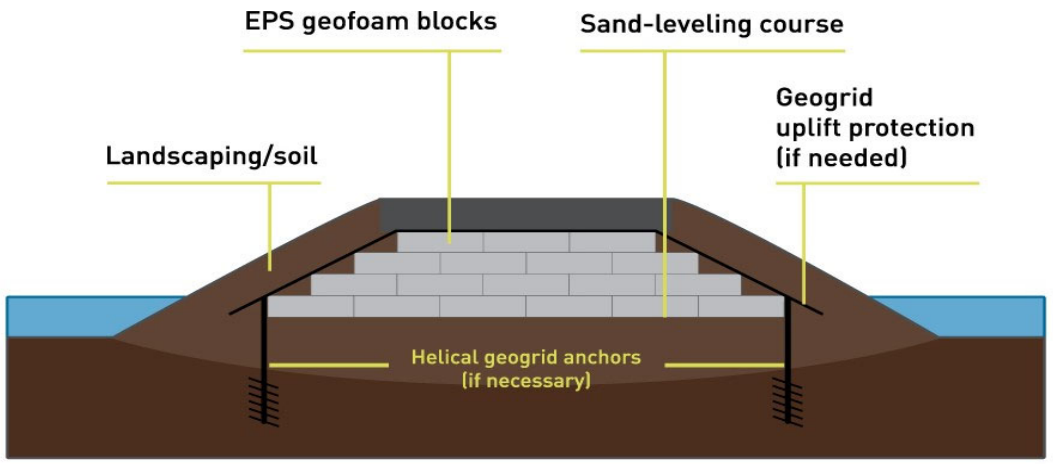
Levees

- Provides volume need to return levee to original configuration.
- Reduces/eliminates additional stress & cycle of settlement & levee raising.



Schematic drawing of levee repair using EPS geofoam

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Airport runway/taxiway

- Replaces unsuitable soils without overloading underlying subgrade materials.
- Controls settlement on highly compressible & saturated soils.
- Prevents differential settlements at intersection of new & existing pavements.

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Geofoam Civil Engineering

Foundations for lightweight structures

- Replaces traditional agricultural pile footings on peat soils.
- Little to no settlement of footings.
- Advantages
  - Lightweight
  - Cost savings
  - Ease of construction
  - Transportability for re-use.

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Special applications

- Noise & vibration dampening
  - Free-standing walls or embankments to reduce highway noise.
  - Reduce transmission of ground borne vibrations under railways or pavements.
- Compressible application
  - Designed for strains beyond 1%.
- Seismic application
  - Reduces seismic forces imposed on buried structures, retaining walls, pipelines, etc.
- Permafrost embankments
  - Insulates underlying permafrost & reduces thawing & thaw-consolidation of ice-rich permafrost soils.
- Rockfall/impact protection
  - Improves performance of protection galleries due to high energy absorption.

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EPS geofoam design considerations

EPS Industry Alliance
Geofoam Civil Engineering

Design considerations

- Lightweight
  - Manufactured in unit weights ranging from 0.7 – 2.85 lbs/cu^3/ft.
  - Imparts small dead load or stress to underlying soils, structures & utilities.
  - Eliminates need for specialized foundations or site preloading to reduce settlement & improve bearing capacity.
  - Reduces lateral stresses behind earth retaining structures.

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Design considerations

EPS geofoam design loads are recommended to not exceed the compressive resistance at 1% capacity.

This limit controls the amount of long-term deflection, or creep, resulting from permanent sustained loads.

- Strength
  - Available in a wide range of compressive resistances.
  - Different types of EPS geofoam can be specified on a single project to maximize savings.
- Ease of handling
  - Handled onsite by laborers or mechanized equipment.
  - Field cut using hot-wire cutter, hand saw or chain saw.

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Design considerations

- Construction time
  - Faster placement rates, reduced utility relocation & less traffic disruption.
  - Not affected by adverse weather conditions.
- Construction cost
  - Adjacent structures can be designed to be less robust/expensive.
  - Lower installation & maintenance costs.
- Stability
  - Permanent material when correctly specified & installed.

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Design considerations

- Insulation
  - Superior, long-term thermal insulation.
- Protection
  - Can be damaged when exposed to certain hydrocarbons.
  - Hydrocarbon resistant geomembranes.
  - Manufactured with flame retardant.
  - Long-term UV exposure is generally surficial & does not cause detrimental property changes.
  - High wind speeds should be monitored; sandbags can be placed on top of EPS geofoam to prevent blocks from shifting.

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Design considerations

- Buoyancy
  - Adequate surcharge or passive restraint must be provided against uplift.
- Water absorption
  - Closed cell structure of EPS limits water absorption.
- Sustainability
  - Can be reground, recycled and reused in composite applications (lightweight concrete, plastic lumber, etc.)
  - Reduced transportation & fuel costs.
  - State-of-the-art manufacturing.

EPS Industry Alliance
Geofoam Civil Engineering

EPS geofoam technical data

EPS Industry Alliance
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EPS geofoam specification

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Oxygen index, min., volume %	24.0	24.0	24.0	24.0	24.0	24.0	24.0

The typical design load limit for EPS Geofoam is the compressive resistance at 1%. Please refer to section 4.2 for additional information.

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Technical data

- Compressive resistance
  - Design recommendation: limit loading to the compressive resistance at 1% strain.
  - Stress at compressive strain of 1% = elastic limit stress.

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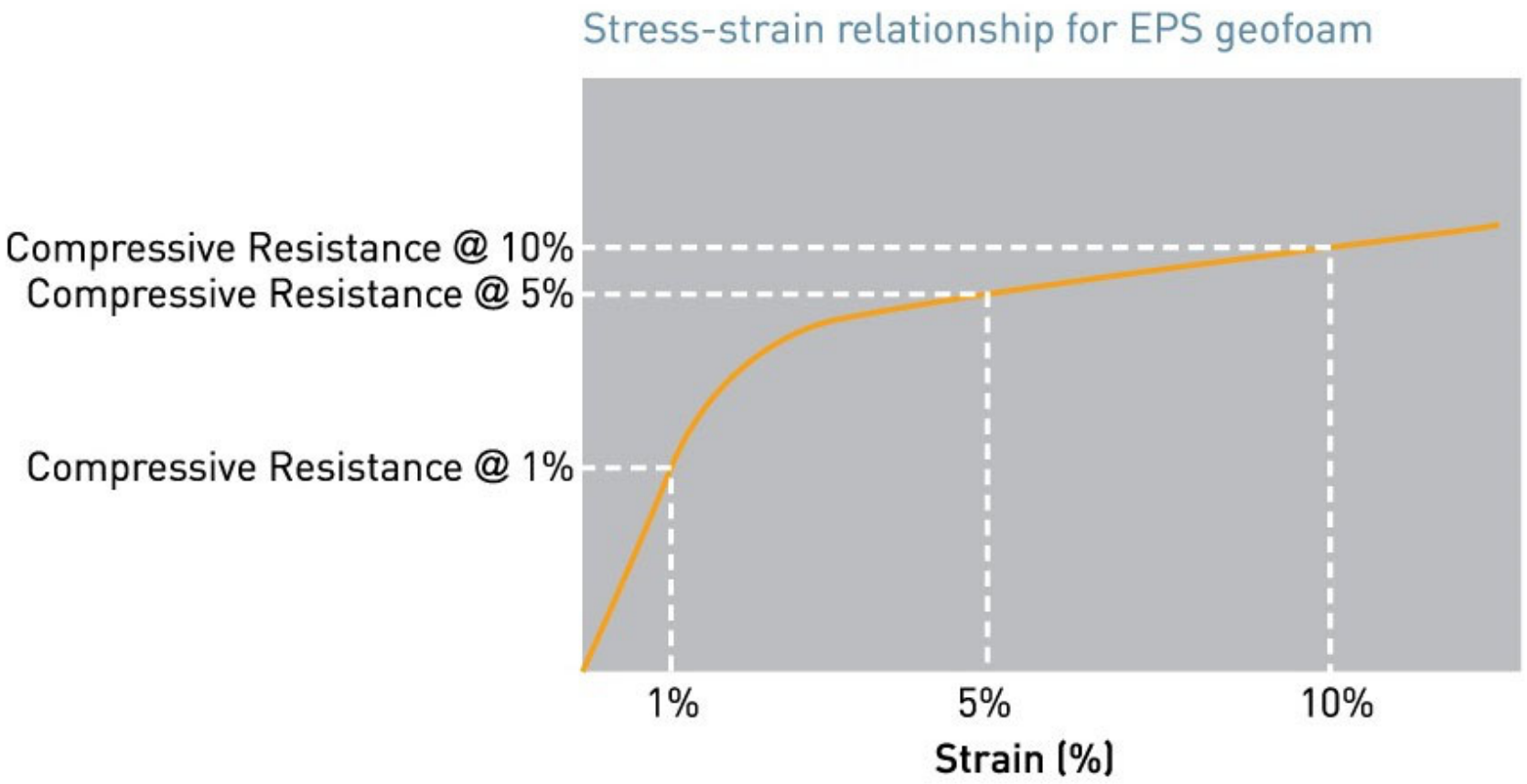
Technical data



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Technical data

- Creep
  - Minimal at strain levels below 1%.
- Load distribution
  - Poisson's ratio ~ 0.12 within the elastic range.
- Coefficient of friction
  - $\mu = 0.5$
- R-value
  - ASTM C578 Standard Specification for Rigid Cellular Polystyrene Thermal Insulation.

EPS Industry Alliance
Geofoam Civil Engineering

Technical data

- Water absorption
  - Closed cell structure of EPS limits water absorption.
  - If installed in a submerged application, an increase in density will occur over time.
- Stability
  - Resistant to fungi & mold.
  - No nutritional value to insects.

EPS Industry Alliance
Geofoam Civil Engineering

Technical data

Chemical Resistance of EPS Geofoam

EPS is resistant to:	Chemicals that may damage EPS:	
• alkalis	• hydrocarbons	• concentrated acids
• dilute inorganic acids	• chlorinated hydrocarbons	• vegetable oils
• gypsum plaster	• organic solvents	• paraffin
• most alcohols	• ketones	• animal fats and oils
• portland cement	• ethers	
• silicone oil	• esters	
• solvent-free bitumen	• diesel and gasoline	

This table provides general guidance but should not be relied upon solely when EPS geofoam could be exposed to chemicals.

EPS Industry Alliance
Geofoam Civil Engineering

Contacts & resources

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Crofton MD 21114
800-607-3772
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www.epsmolders.org

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West Conshohocken, PA 19428-2959
www.astm.org

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Federal Highway Administration
1200 New Jersey Ave. SE
Washington, DC 20590
202-366-4000
www.fhwa.dot.gov

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Syracuse University
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National Cooperative Highway Research Program (NCHRP) Transportation Research Board
The National Academies
500 Fifth St. NW
Washington, DC 20001
202-334-2934
www.trb.org/NCHRP/Public/NCHRP.aspx

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