



GeoFoam Technical Manual



**GEOFOAM PREMIUM POLYSTYRENE LIGHTWEIGHT
FILL TO MEET ANY CONSTRUCTION CHALLENGE**

LIGHTWEIGHT CONSTRUCTION SOLUTIONS FOR ENGINEERS AND SPECIFIERS

EXPOL supplies a range of products that provide solutions for insulation and lightweight construction, so you can focus on the things you do best.

EXPOL has a wide range of solutions made possible by the dynamic nature of Expanded Polystyrene (EPS) and Extruded Polystyrene (XPS) foams. All EXPOL products are tested by a variety of institutions, including BRANZ, to ensure quality and reliability.

These products are so efficient they can save up to 200 times their own resource in thermal energy savings.

EXPOL also runs six of the country's biggest EPS recycling plants, ensuring the sustainability of EPS building products.

EXPOL operates six manufacturing facilities in New Zealand to ensure our customers get fast and reliable service at the lowest possible price. EXPOL also has manufacturing partners throughout Australia.

EXPOL GeoFoam

APPLICATIONS AND USE

- ◆ Specialised Pod Floors
- ◆ Road Construction Over Poor Soils
- ◆ Bridge Abutment
- ◆ Bridge Underfill
- ◆ Culverts, Pipelines & Buried Structures
- ◆ Floating / Compensating Foundation
- ◆ Landscaping & Slope Stabilisation
- ◆ Retaining Wall and Buried Wall Landfill

SPECIAL APPLICATIONS

- ◆ Noise and Vibration Damping
- ◆ Compressible Application
- ◆ Seismic Application
- ◆ Permafrost Embankments
- ◆ Permafrost Embankments
- ◆ Rockfall/ Impact Protection
- ◆ Design Considerations
- ◆ Lightweight
- ◆ Strength
- ◆ Ease of handling
- ◆ Construction time
- ◆ Construction cost
- ◆ Stability

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STRONG LIGHTWEIGHT FILL



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EXPOL GEOFOAM EXPANDED POLYSTYRENE LIGHTWEIGHT FILL

Expanded Polystyrene – has been used as a geotechnical material since the 1960s. **EXPOL GeoFoam** is approximately 1% the weight of soil and less than 10% the weight of other lightweight fill alternatives. As a lightweight fill, **EXPOL GeoFoam** reduces the loads imposed on adjacent and underlying soils and structures.

EXPOL GeoFoam is not a general soil fill replacement material but is intended to solve engineering challenges. The use of EXPOL GeoFoam typically translates into benefits to construction schedules and lowers the overall cost of construction because it is easy to handle during construction, often without the need for special equipment, and is unaffected by occurring weather conditions. In addition, EXPOL GeoFoam can be easily cut and shaped on a project site, which further reduces jobsite challenges. EXPOL GeoFoam is available in numerous material types that can be chosen by the designer for a specific application. Its service life is comparable to other construction materials and it will retain its physical properties under engineered conditions of use.

EXPOL GeoFoam is produced in blocks that can be cut into various shapes and sizes - and a range of compressive resistances - to suit specific project needs (see page 13). As an engineered product, it can be produced to obtain the required compressive resistance.

EXPOL GeoFoam density, only about 1% that of soil and rock, is controlled during the manufacturing process, making it a superior, ultra-lightweight fill material that significantly reduces the stress on underlying subgrades. The lighter load can reduce settlements and can improve stability against bearing and slope failures.

PRODUCT OPTIONS & SIZES

	Length (mm)	Width (mm)	Thickness (mm)
EXPOL GeoFoam (S, M, H, VH)	2450	1220	620
	4900	1220	620

Any size can be cut from these blocks



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EXPOL GEOFOAM APPLICATIONS AND USE

EXPOL GeoFoam is inherently multi-functional, which makes it effective to use in a wide variety of applications. It offers special advantages for construction on soft ground, slope stabilisation and retaining walls.

Expanded Polystyrene has been used in road and airport tarmacs and railway track systems, beneath refrigerated storage buildings, sports arenas and storage tanks to prevent ground freezing and heaving and in below-ground building segments to reduce seasonal heating and cooling requirements.

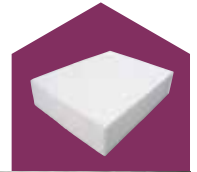
EXPOL GeoFoam enables engineers, architects, and builders to design for key geosynthetic functions and select the best combination of products to achieve project goals. With unprecedented strength and flexibility, EXPOL GeoFoam also offers innovative solutions to a range of problems, including protection from earthquake shock and noise and vibration dampening.

SPECIFIERS AND ENGINEERS

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Applications and Use

FLOATING FOUNDATION



EXPOL GeoFoam can be used as a compensating foundation to reduce the load on underlying compressible soils and minimize building settlement along with potential bearing capacity problems. Existing soil is excavated to reduce the net applied load to the soil

by the new structure. If the amount of soil excavated equals the full weight or stress applied by the new structure, the foundation is called "floating" or "fully compensating."



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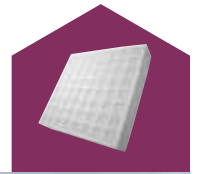


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COMMERCIAL POD FLOORS



EXPOL GeoFoam is often used in raft type pod floors. The combination of deep and thicker concrete ribs along with high density polystyrene pods creates a highly engineered foundation (See table page 13). The pods are cut to size to suit each particular project however to

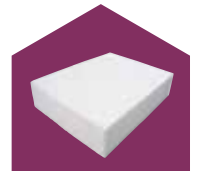
minimise cutting and wastage it is important to design the foundation rib spacings around the most economical GeoFoam pod sizes where permissible.



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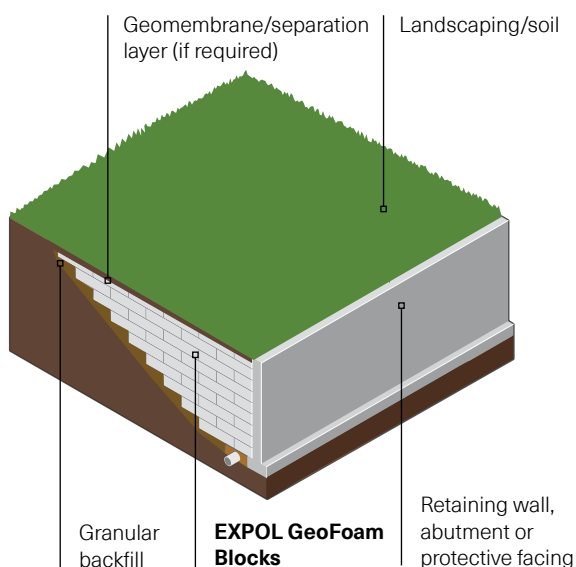
RETAINING WALLS



EXPOL GeoFoam can be used as backfill behind retaining and buried structures to greatly reduce lateral pressures on the structure. Because the horizontal pressure acting on a retaining wall is proportional to the weight of the backfill, a less robust retaining structure is needed if the backfill soil in the active zone behind the retaining wall is replaced with EXPOL GeoFoam.

Likewise, the use of EXPOL GeoFoam backfill behind retaining and buried structures also limits the horizontal forces that can develop during earthquakes. In retaining wall applications, adequate drains should be provided to prevent the development of hydrostatic pressure and uplift due to buoyancy for sites with shallow groundwater and loose soils.

Schematic drawing of retaining wall with EPS GeoFoam backfill



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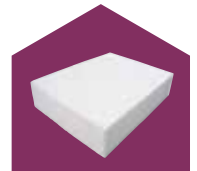


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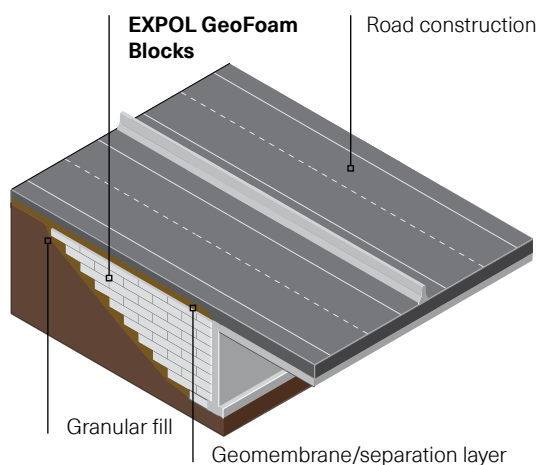
BRIDGE ABUTMENT



There are several advantages to using EXPOL GeoFoam to construct approach fills for bridge abutments. Because of its high compressive resistance, EXPOL GeoFoam can safely support highway loading without over-stressing the underlying soils. This usually results in less differential movement at the bridge/approach fill interface, which reduces the construction cost of the approach slab and its long-term maintenance. In addition, when compared to traditional embankment

fills, EXPOL GeoFoam imparts significantly reduced lateral forces on abutment walls, foundations and other retaining structures, because the transmitted lateral force is proportional to the weight of the backfill. If this weight is substantially reduced, as with the case of EXPOL GeoFoam backfill, this leads to savings in the design of bridge abutment and other walls, which are no longer required to resist large horizontal static and dynamic forces.

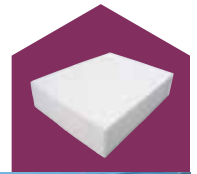
Schematic drawing of GeoFoam used to construct bridge abutment



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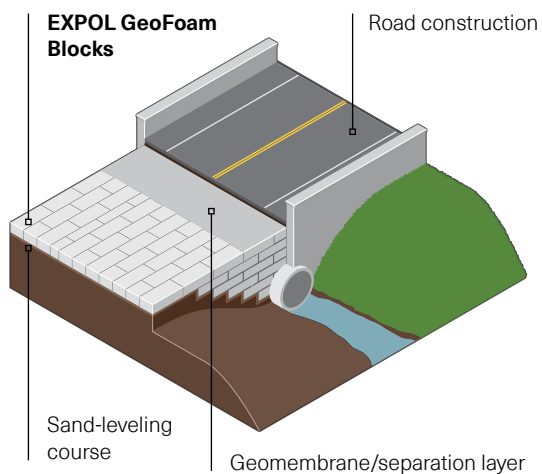
CULVERTS AND PIPELINES



Engineering plans often call for the placement of new fill over existing underground structures that were not designed to support the increased loads. Rather than removing or strengthening the existing

underground structures, the new fill load can be reduced to a tolerable level by using EXPOL GeoFoam instead of heavier traditional fills.

Schematic drawing of EPS GeoFoam fill over existing culvert



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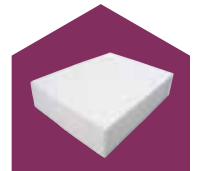


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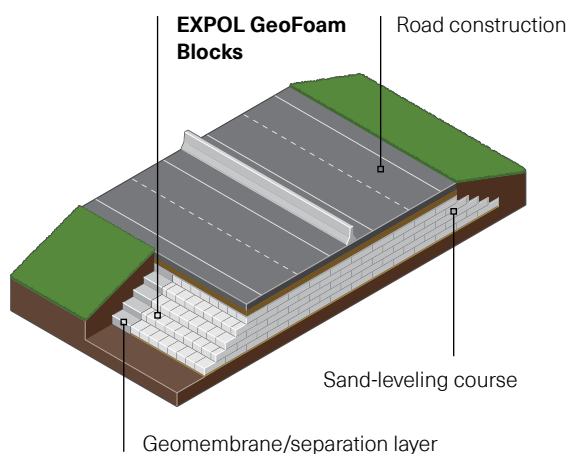
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ROAD CONSTRUCTION OVER POOR SOILS



The growing need for new roads may, in many cases, require construction over soft or loose soils that are incapable of supporting additional loads. Designers must identify innovative materials and construction techniques to address the problem of building on soft soils or where sensitive existing utilities or wetlands are present while, at the same time, accelerating project schedules. EXPOL GeoFoam can be used to replace compressible soils or in place of heavy fill materials to prevent unacceptable loading on underlying soils and adjacent structures. The high compressive resistance of EXPOL GeoFoam makes it able to adequately support traffic loadings associated with roads and state highways. Construction with EXPOL GeoFoam also saves time because EXPOL GeoFoam is easy to handle without the need for special equipment. Because EXPOL GeoFoam is an engineered product it arrives on site already having undergone rigorous Q&A testing, unlike other fill materials that require time consuming QA/QC testing. A description of a typical road construction, from

Cross section of road construction using EXPOL GeoFoam and overlaying pavement system.



bottom to top, is as follows: compact a layer of sand at the base of the roadway excavation to provide a level and free draining construction surface. Place the EXPOL GeoFoam to the desired height, staggering the vertical joints in each course so as not to create continuous vertical seams.

If required, a separation layer may be placed between the top of the EXPOL GeoFoam and the overlying pavement system. A separation layer can have two functions: to enhance the overall performance and life of the pavement system by providing reinforcement, separation and/or filtration and to enhance the durability of the EXPOL GeoFoam both during and after construction. Choices for the separation layer include geotextile, hydrocarbon resistant geomembrane fill, or a reinforced concrete slab. For example, if protection against fuel spills is desired, a hydrocarbon resistant geomembrane cover can be placed over the uppermost EXPOL GeoFoam block course to protect from possible hydrocarbon attack. Alternately, a reinforced concrete load distribution slab can be used to protect the EXPOL GeoFoam from hydrocarbon attack and from potential overstressing resulting from heavy traffic loads. Other structural features (i.e., tilt-up panel slabs, impact barriers, light and power poles, etc.) can be anchored to the load distribution slab.

The roading system, which generally consists of select fill, road base gravel and an asphalt or concrete driving surface, is subsequently constructed atop the separation layer. Prevention of differential icing is a consideration when using EXPOL GeoFoam in roadway construction in cold climates.

Differential icing is defined as the formation of ice on the surface of an insulated pavement, when the adjacent, non-insulated pavement remains ice-free. When constructed next to existing roadways, sections of pavement constructed over EXPOL GeoFoam can form ice prior to adjoining areas because EXPOL GeoFoam is an excellent insulator, which prevents heat from reaching the pavement from the underlying soil. One way to address this concern is to keep the top level of the EXPOL GeoFoam at or below the appropriate frost line for the region. For example, for a frost line of (0.9 meters), a minimum separation layer and pavement system material thickness of (0.9 meters) should be provided over the EXPOL GeoFoam.



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DESIGN CONSIDERATIONS

There are numerous design considerations for EXPOL GeoFoam applications. These considerations include engineering properties and construction factors. This section presents some of the advantages and unique features of building with EXPOL GeoFoam, as well as precautions that must be followed.

Lightweight

EXPOL GeoFoam is manufactured in various unit weights that typically range from about 12 – 28 kilograms per cubic meter. As a result, they impart small dead load or stress to underlying soils, structures and utilities. This is especially advantageous where the existing soils are poorly suited to support additional loading (e.g., compressible clay, peats, etc.). In fact, existing loads can be significantly reduced by excavating and replacing native soils, which commonly weigh about 1.60 kilograms per cubic meter, with EXPOL GeoFoam. This can eliminate the need for specialised foundations or site preloading to reduce settlement and improve bearing capacity. The use of EXPOL GeoFoam over existing utilities can eliminate the need for utility relocation. The use of EXPOL GeoFoam behind earth retaining structures, such as bridge abutments, can reduce lateral stresses.

Strength

EXPOL GeoFoam is available in a range of compressive resistances (See table page 13). A project designer can choose the specific type of Expanded Polystyrene required to support the design loading while minimising cost. Several different types of EXPOL GeoFoam can be specified on a single project to maximise savings. For example, higher strength EXPOL GeoFoam can be used in high applied stress areas while lower strength blocks are used in areas where the applied stresses are lower.

EXPOL 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. Note: Adequate soil cover, or a load distribution slab, may be needed to distribute heavy concentrated loads.

Construction time

EXPOL GeoFoam helps projects maintain extremely tight construction schedules. The ease and speed with which EXPOL GeoFoam can be constructed results in shorter construction time because of faster placement rates, reduced utility relocation and less disruption of traffic in urban areas. Additionally, adverse weather conditions typically do not affect placement rates of EXPOL GeoFoam.

Ease of handling

No special equipment is required when building with EXPOL GeoFoam. Blocks can often be carried and set in place by labourers or easily handled with mechanised equipment. This is an important consideration when the construction site is congested or does not have the clearances required for traditional placement or compaction equipment. EXPOL GeoFoam can be field cut using a hot-wire cutter, hand saw or chain saw. The EXPOL GeoFoam can be trimmed on site to accommodate the shapes of existing underground utilities and services.

Construction cost

In addition to other project costs, using EXPOL GeoFoam reduces the loading on adjacent supporting structures. Adjacent structures can be designed to be less robust and therefore less expensive. This is particularly important for underground utilities. Typically, the higher cost of some types of lightweight fill materials is usually offset by savings when all of the project costs are considered, such as lower installation costs and lower maintenance. Available in a range of compressive resistances, EXPOL GeoFoam allows for economical project design.

Stability

EXPOL GeoFoam is considered a permanent material when correctly specified and installed.

Insulation

Expanded Polystyrene is an efficient thermal insulator. Expanded Polystyrene has been used for many years as insulation for various building applications. Although some applications may not directly utilise the insulation value of EXPOL GeoFoam, this aspect should be considered in all designs.



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PROTECTION

Chemical Exposure

EXPOL GeoFoam can be damaged when exposed to certain hydrocarbon chemical and may need protection. There are a number of hydrocarbon resistant geomembranes that are suitable for protection of EXPOL GeoFoam. Make sure that the geomembranes used are compatible with Expanded Polystyrene. For example, polypropylene, polyethylene, chlorosulphonated polyethylene (CSPE) and Ethylene Interpolymer Alloys (EIAs) are compatible geomembranes. If using EXPOL GeoFoam in a location with contaminated soils, laboratory testing should be performed to determine the nature of the contaminants and their possible effects.

Fire

Like many construction materials, Expanded Polystyrene is combustible. EXPOL GeoFoam is manufactured with a flame retardant. Appropriate precautions should be implemented at project sites if open flame procedures, such as welding, will be performed. In geotechnical finished applications EXPOL GeoFoam is protected from exposure by soil, concrete or other cover materials. When used within buildings, gypsum board or concrete should be used for protection.

- Expanded Polystyrene is combustible.
- A flame retardant is part of EXPOL GeoFoam. This retardant inhibits the early stages of fire development.

UV Light

Expanded Polystyrene is susceptible to ultra violet degradation if exposed to sunlight for long periods of time. Degradation caused by prolonged exposure to sunlight is generally surficial (yellow coloured dust) and does not cause detrimental property changes of practical importance. This discolouring can be removed by power washing or a grinder, if desired.

Wind

Wind speeds should be monitored during construction to determine if overburden weight restraints such as sandbags should be placed on top of the EXPOL GeoFoam to prevent the blocks from shifting.

Buoyancy

Because of its closed-cell structure and light weight, EXPOL GeoFoam is buoyant. Care must be taken during design, construction and post-construction to ensure that the potential flotation forces are accounted for within the hydrological conditions of the site. Adequate surcharge, i.e., soil or pavement cover, or an alternate means of passive restraint must be provided against uplift.

Alternately, the material can be installed above the water table or the water table can be lowered using suitable drains or other dewatering systems. Drainage (generally a sand or gravel layer) can be provided between the EXPOL GeoFoam fill and the natural soils to reduce potential uplift forces. Providing for adequate drainage of groundwater and/or surficial waters below the EXPOL GeoFoam prevents water from infiltration and reduces the development of uplift forces.

Water Absorption

EPS has a closed-cell structure that limit water absorption. When used in well-drained conditions, no change in EXPOL GeoFoam weight is expected over time. A slight increase in the weight of EXPOL GeoFoam can be expected over time due to water absorption if installed in a submerged application.

Sustainability

EXPOL GeoFoam can be reground, recycled and reused in many composite applications such as insulation, void form pods, non-structural fill, drainage material etc. All EXPOL products including EXPOL GeoFoam are reground, recycled and reused. Compared with traditional fill materials, fewer trucks with lighter loads are required to deliver EXPOL GeoFoam to a project site. This means less pollution from fuel emissions and less wear and tear on the roadways and infrastructure.

Traditional soil fills are constructed in thin lifts with repeated compaction. This requires considerable time, construction equipment, fuel to operate the equipment and testing to ensure adequate compaction. For soft soil conditions, significant waiting time is required after fill placement while the underlying foundation soil consolidates and settles. In contrast, EXPOL GeoFoam can be quickly placed with no need for compaction or waiting for consolidation to occur. Because each block is equivalent to the height of several soil lifts, construction proceeds more rapidly. In addition, EXPOL GeoFoam is unaffected by the normal range of climate and moisture conditions so construction can proceed without regard to weather.

Traditional soil fills have to be constructed and compacted within relatively narrow soil moisture conditions to achieve the desired dry unit weight. In addition, because gravity loads and the lateral forces that develop under static and seismic loads are proportional to backfill material density, i.e., the greater the backfill density, the greater these loads. The use of lightweight EXPOL GeoFoam significantly reduces these loads.

Warranty

Provided EXPOL GeoFoam has been correctly installed to manufacturers specifications then it shall have a serviceable life of not less than fifty years.

TECHNICAL DATA

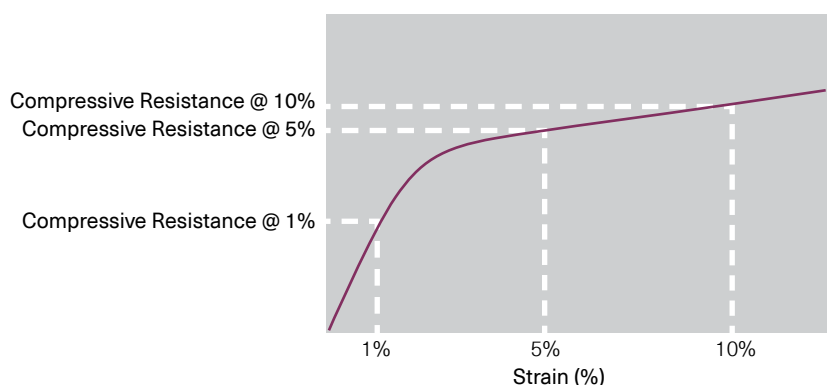
EXPOL GeoFoam types

EXPOL GeoFoam is available in different material types. Thorough knowledge and understanding of the type being used on a EXPOL GeoFoam project is essential.

PRODUCT PROPERTIES

Property	Unit	RECYCLED	EXPOL GeoFoam S	EXPOL GeoFoam M	EXPOL GeoFoam H	EXPOL GeoFoam VH	Test Reference
Material		EPS	EPS	EPS	EPS	EPS	
Density	kg/m ³	14	16	20	24	28	
Compressive Resistance	KPA at 1%	17	34	49	64	88	AS 2498.3.1993
Compressive Resistance	KPA at 2%	34	59	96	108	142	
Compressive Resistance	KPA at 5%	48	74	111	133	172	
Compressive Resistance	KPA at 10%	57	84	126	146	189	
Youngs Modulus	(MPa)	2.2	3.8	4.1	6.2	8	
Cross breaking strength	KPA	90	165	200	260	320	AS 2498.4
Determination of flame propagation surface ignition							AS2122.1-1993
Medium flame duration (max)	sec	2	2	2	2	2	
Eighth value	sec	3	3	3	3	3	
Fire behaviour - Spread of Flame Index	(0-10)	0	0	0	0	0	AS/NZS 1530.3:1999
- Smoke Developed Index	(0-10)	5	5	5	5	5	
Dimensional stability of length, width & thickness (max) at 70 deg C for 7 days	%	1	1	1	1	1	AS2498.6
Rate of water vapour transmission (max) measured parallel to rise at 23°C	mg/m ² s	750	520	520	460	400	AS 2498.5

Stress – strain relationship for EPS GeoFoam



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Compressive Resistance

Expanded Polystyrene behaves as a linear elastic material up to a strain of about 1% as shown on page 13 that depict the stress-strain response of EPS. As a result, the design recommendation for EXPOL GeoFoam is to limit loading to the compressive resistance at 1% strain.

The stress at a compressive strain of 1% is called the elastic limit stress and is measured in a Standard rapid-loading compression test. Except for special compressible applications, higher compressive strain, e.g., 5 or 10%, is not used to estimate the Expanded Polystyrene strength because these strains are past the yield strength of the Expanded Polystyrene and this may lead to undesirable permanent strains.

Creep

Creep behaviour of Expanded Polystyrene is minimal at strain levels below 1%, which is another reason for using a compressive resistance at 1% strain for design of EPS GeoFoam. Creep effects increase significantly at higher strains, e.g., 5 and 10%. In summary, a compressive resistance at 1% ensures adequate performance and acceptable creep behaviour in EXPOL GeoFoam applications.

Load distribution

Poisson's ratio for EPS is approximately value of 0.12 within the elastic range.

Coefficient of friction

The coefficient of friction, μ , between EXPOL GeoFoam is 0.5 along moulded faces. It is higher along cut faces where there is increased roughness. The coefficient of friction for a wire cut face can be assumed to be the same as a moulded face or 0.5. If yellowing of the block surface occurs due to UV exposure, the block should be brushed to remove the residue and a coefficient of friction of 0.5 can be used.

Water absorption

Expanded Polystyrene has a closed-cell structure that limits water absorption. An increase in density of EXPOL GeoFoam can be expected over time due to water absorption if the blocks are installed in a submerged application.

R-value

Expanded Polystyrene is an efficient thermal insulator. For construction applications, the polystyrene foam industry has developed test data as reported in ASTM C 518 - 04 Standard Specification for Rigid Cellular Polystyrene Thermal Insulation. Although some EXPOL GeoFoam applications may not directly utilise the insulation value of EXPOL GeoFoam, this aspect should be considered in all designs.

Stability

EPS is resistant to fungi and mould and offers no nutritional value to insects or vermin.

Chemical resistance

Expanded Polystyrene is not soluble in water. Expanded Polystyrene is resistant, at ambient temperature, to:

- alkalis
- dilute inorganic acids
- gypsum plaster
- most alcohols
- silicone oil
- solvent-free bitumen

Expanded Polystyrene can be damaged by, and should not come in contact with the materials below. Protect EXPOL GeoFoam from contact with these materials both during construction and after project completion using an appropriate hydrocarbon-resistant geomembrane or other physical barrier:

- hydrocarbons
- chlorinated hydrocarbons
- organic solvents
- ketones
- ethers
- esters
- diesel and gasoline
- concentrated acids
- vegetable oils
- animal fats and oils
- paraffin

If using EXPOL GeoFoam in a location of contaminated soils, laboratory testing should be performed to determine the nature of the contaminants, e.g. methane, and their possible impact on the EPS GeoFoam.

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.





SOLID INSULATION AND LIGHTWEIGHT CONSTRUCTION SOLUTIONS



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