

EPS BLOCK SYSTEM FOR CIVIL ENGINEERING APPLICATIONS



CONCRETE
FORMWORK

NOISE BARRIERS/WALLS
/FOUNDATIONS

BRIDGE ABUTMENTS

STEEP SIDE HILLS

BRIDGE SHUTTERING

RMAX GeoFoam®

WEIGHT REDUCTION
ON UTILITIES

ROAD FOUNDATIONS

RMAX is a division of
Huntsman Chemical Company
Australia Pty. Limited
ABN 48 004 146 338

HUNTSMAN
Enriching lives through innovation

CONTENTS

Introduction	1
How does RMAX GeoFoam ® work?	2
Has RMAX GeoFoam ® been proven?	2
 RMAX GeoFoam® Civil Construction Applications	 3
RMAX GeoFoam ® civil applications and use	3
The compressible inclusion function of RMAX GeoFoam ®	4
Selection of compressible inclusion materials	4
Compressible inclusion applications	5
RMAX GeoFoam ® for use in road construction	7
RMAX GeoFoam ® application in road widening	8
RMAX GeoFoam ® application in airport runway/railway construction	9
RMAX GeoFoam ® in bridge abutment construction	9
RMAX GeoFoam ® for culverts, pipelines and buried structures	10
RMAX GeoFoam ® used for landscaping design	11
RMAX GeoFoam ® use in retaining and buried wall backfill	12
RMAX GeoFoam ® use in slope stabilization	12
RMAX GeoFoam ® use in levee construction design	13
RMAX GeoFoam ® use in compensating foundations and foundations for lightweight structures	14
RMAX GeoFoam ® use in tiered seating applications for stadiums & theatres	14
RMAX GeoFoam ® use in noise and vibration damping applications	15
 RMAX GeoFoam® Construction Principles	 16
General	16
Supporting layers	16
Construction of RMAX GeoFoam ® installations	16
Construction above the RMAX GeoFoam ® installation	17
Embankment slopes	17
Subsidiary highway components	17
Anchoring of RMAX GeoFoam ®	18
RMAX GeoFoam ® block layout	18
RMAX GeoFoam ® ease of handling and installation	18
Construction time & cost savings using RMAX GeoFoam ®	18
 RMAX GeoFoam® Design Considerations	 19
RMAX GeoFoam ® chemical exposure	19
RMAX GeoFoam ® compressive resistance	20
RMAX GeoFoam ® creep behaviour	20
RMAX GeoFoam ® lateral resistance (Coefficient of Friction)	20
RMAX GeoFoam ® load distribution: (Poisson's Ratio)	21
RMAX GeoFoam ® load bearing strength characteristics	21
RMAX GeoFoam ® lightweight characteristics	21
RMAX GeoFoam ® California Bearing Ratio (CBR)	22
 RMAX GeoFoam® Physical Properties	 24
RMAX GeoFoam ® Physical Properties Table	24
RMAX GeoFoam ® product stability	25
RMAX GeoFoam ® insulation characteristics	25
RMAX GeoFoam ® protection from exposure to fire	25
RMAX GeoFoam ® UV light exposure	25
RMAX GeoFoam ® wind exposure	26
RMAX GeoFoam ® buoyancy	26
RMAX GeoFoam ® water absorption characteristics	27
RMAX GeoFoam ® product sustainability	27
 RMAX GeoFoam® 50 year Limited Product Warranty	 28
RMAX Sales and Service	29
RMAX GeoFoam® Technical Brochure References	29

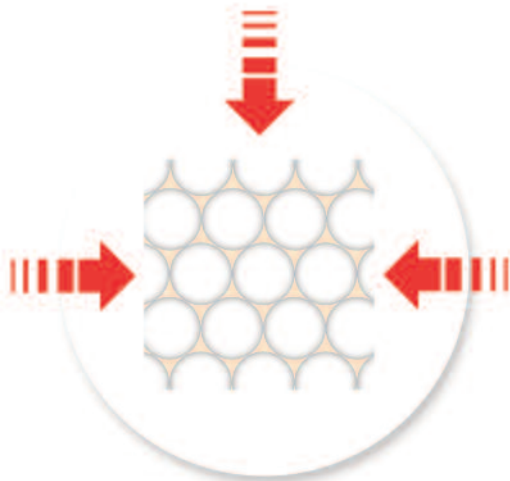
NOTE:

As RMAX continually tests, validates and improves the RMAX **GeoFoam® product, the information presented in this technical brochure may have been updated since it was last printed. For the most up to date version of the RMAX **GeoFoam**® Technical Data Manual please visit the RMAX website at www.rmax.com.au**

Introduction

RMAX **GeoFoam®** is a high performance fill material consisting of fused expanded polystyrene (EPS) bead making it a stable and exceptionally lightweight material specifically designed for application in civil engineering and commercial building construction applications. RMAX **GeoFoam®** has been used as a material in geotechnical applications in Australia since the early 1990's and in various parts of Europe and the United States since the 1970's.

RMAX **GeoFoam®**'s **remarkable strength to weight ratio** makes it the ideal choice for absorbing heavy structural and mechanical loads and **reducing underlying soil stresses** which in turn helps to stabilise roads, steep embankments, bridge abutments and sensitive below ground pipe work. Typically for the same occupied volume, RMAX **GeoFoam®** block weighs approximately 1% of the weight of most soil and rock types and 10% of the weight of some other light weight fill materials. It is also a highly versatile material that can be easily used as a **quick** and easy **cost-saving** method for concrete form-work or weight reduction on foundations. It has numerous potential uses.



*The cellular structure of RMAX **GeoFoam®** helps to absorb and dissipate crush loads and its cellular structure results in Isotropic physical properties - the physical properties are the same in all directions.*

RMAX **GeoFoam®** is made as blocks from EPS beads that have been expanded and bonded together under heat and pressure to produce a high performance construction material with a unique set of structural properties such as;

- 1 Exceptional strength to weight ratio
- 1 Resistance to water absorption
(substantially reduces the problems of leaching)
- 1 Unattractiveness to insect, bacterial and fungal attack
- 1 Safe and simple to handle

RMAX **GeoFoam®** has Isotropic physical properties which means that the physical characteristics of the material are the same in all directions – not all materials provide this feature.

These superior characteristics ensure the durability, performance and longevity of RMAX **GeoFoam®** and has seen its popularity grow as increasing numbers of civil engineers and construction specifiers recognise its performance and cost saving benefits.

In simple terms RMAX **GeoFoam®** is your complete high performance fill solution.

How does RMAX GeoFoam® work?

The advanced technologies used in the manufacture of RMAX GeoFoam® result in a **unique material** that is 98% air captured within a 2% cellular matrix.

It is this cellular structure that provides RMAX GeoFoam® with the unique set of attributes of compressive strength, lightweight and block rigidity. The combination of these characteristics enables an even distribution of load forces with minimal to no deformation or creep over time.

In most cases RMAX GeoFoam® significantly out performs traditional fills in structural stability and versatility allowing it to be used in a wide variety of applications.

Has RMAX GeoFoam® been proven?

For over 40 years expanded polystyrene (EPS) has proven itself to be a reliable and dependable material. Geofoam use in civil engineering commenced in Scandinavia in 1971 and in the United States of America in 1974. Since that time geofoam has been used in geotechnical applications across the world.

RMAX GeoFoam® has been used in geotechnical applications in Australia since 1992 commencing with the construction of Lynch's Bridge in Maribyrnong, Victoria. It has been extensively researched and tested and meets many of the industries most rigorous standards.

Listed below are some recent Australian civil construction projects where RMAX GeoFoam® has been used:

Victoria:

Power Street Bridge project-North Abutment (Approx. 4000 m³)
Victorian Water Desalination Plant project Wonthaggi (Approx. 4000 m³)
Sky Road Peninsula Freeway Link project (Approx. 1000 m³)

Western Australia:

Perth Crown Casino Project (Approx. 6000 m³)
Perth Royal Children's Hospital upgrade project (Approx. 1000 m³)

New South Wales:

Mt Ousley Road widening project (Approx. 1000 m³)
Madam Butterfly Opera Stage creation project (Approx. 800 m³)
Moore Park Tunnel construction Cross City Tunnel project
Scarborough slip road reconstruction

Queensland:

Pensar Civil Engineering: Banksia Drive Stage 1 project (Approx. 800m³)
Transcity Joint Venture: Legacy way tunnel project (Approx. 1100m³)
Port Motorway Project Clem Tunnel Northern Busway project

South Australia:

Adelaide Convention Centre Montefiore Bridge Project (Approx. 260 m³)
Whyalla Marine Pontoon project (Approx. 200 m³)

*Standard block dimensions of RMAX GeoFoam® -
5000mm x 1200mm x 600mm
Density and Grade are matched to the specific physical
requirements of each project.*



RMAX GeoFoam® Civil Construction Applications

RMAX GeoFoam® civil applications and use

RMAX GeoFoam® is produced in moulded blocks of various sizes – the most common being **5m x 1.2m x 0.6m**. RMAX GeoFoam® moulded blocks are manufactured at RMAX manufacturing plants across Australia in densities ranging from 12g/l through to 38 g/l, providing a wide range of compressive stress resistance performance as well offering a unique set of characteristics and physical performance properties making RMAX GeoFoam® a superior product choice for a wide range of civil construction applications.

With excellent flexibility and strength, RMAX GeoFoam® offers innovative solutions to a range of common civil engineering challenges that structural designers commonly face today, including but no limited to high load bearing capacity, protection from earthquake shock and noise and vibration dampening.

RMAX GeoFoam® also offers special advantages for construction on soft ground, to provide slope stabilisation, in retaining walls and bridge abutments, for road and airfield pavements, railway track systems, and landscaping and tiered seating construction requirements for theatres and sports arenas. The proceeding information covers the application of RMAX GeoFoam® in the most common civil applications as mentioned above, as well as some more specialised applications.



RMAX GeoFoam® Civil Construction Applications

The compressible inclusion function of RMAX GeoFoam®

In general a compressible inclusion is any material that is significantly more compressible, at least in one direction, than other materials that it is in contact with. Using a compressible inclusion can result in **significant reduction** in earth pressures under static and dynamic loading. A compressible inclusion can also be used to accommodate ground or structure movement. Using a compressible inclusion can be cost effective for both new construction as well as rehabilitating or upgrading existing structures.

Geotechnical applications suitable for a compressible inclusion include behind earth retaining structures, around foundation elements, and above pipes, culverts and tunnels. Because the inclusion is the most compressible component of the structure-inclusion-ground system, the inclusion will deform more readily than the other system components under applied stress or displacement.

This selective compression of the inclusion can result in a variety of benefits. Most often, this is a load on the structure that is **significantly less** than if no inclusion were present. In many cases use of a compressible inclusion is a more cost effective alternative than designing the structure to withstand the greater load.

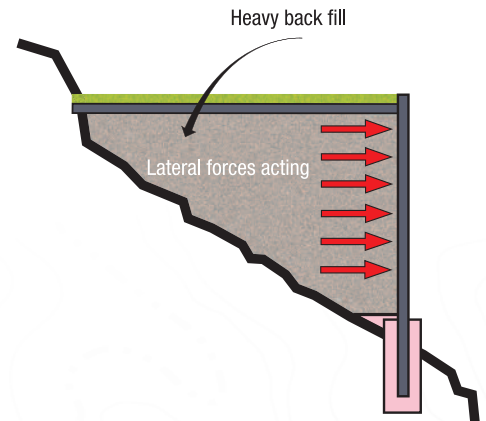
Selection of compressible inclusion materials

RMAX GeoFoam® is an excellent material for compressible inclusions because it has **predictable** and **controllable** stress strain behaviour and maintains predictable behaviour when wet. It also does not decompose when wet.

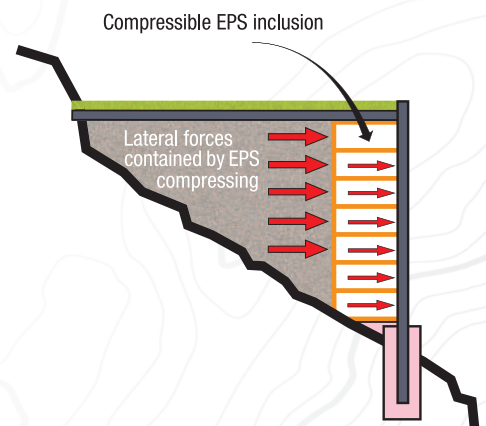
For compressible inclusion applications stiffness of the geofoam in the primary displacement direction is the most relevant property.



Without Compressible Inclusion



With Compressible Inclusion



RMAX GeoFoam® Civil Construction Applications

Compressible inclusion applications

For compressible inclusion applications, the lowest density EPS is generally desirable as both the Initial Young's Modulus and Compressive Strength (typically defined as compressive stress at 10% strain) decrease with decreasing density. Experience indicates that the minimum EPS density that strikes a balance between stiffness and durability is approximately 12 kg/m³.

Examples of the use of Compressible Inclusions:

1. Volume change of earth materials.

There are several situations where volume changes of soil and rock are caused by physical changes within the material.

Examples include:

- swelling and freezing soils, and
- rocks that swell due to water absorption, mineral changes, or release of tectonic stresses.

When such materials are adjacent to earth retaining structures, especially rigid, non-yielding ones, the lateral pressure generated by the expanding soil or rock can be significant.

The use of a **compressible inclusion** between the structure and ground can allow the soil or rock to deform laterally while **transmitting only a fraction of the stress to the structure**. The use of a compressible inclusion to reduce lateral pressures due to swelling soils is particularly attractive given the extensive occurrence of such soils worldwide.

Designing to eliminate, or at least minimize, the effects of such soils, or remediating structural damage they cause, represents a significant cost in many areas.



RMAX GeoFoam® Civil Construction Applications

2. Accommodating structure movement.

There are situations where lateral displacement of an earth retaining structure is caused by external factors other than lateral earth pressures.

This occurs primarily in rigid, indeterminate structures subjected to temperature-induced strain. Examples include bridges, especially those with internal abutments.

In some cases, this movement can result in lateral earth pressures on the retaining structure in excess of at rest and approaching the passive state. The traditional approach is to design the structure for these elevated potential earth pressures. In some cases, it is necessary to repair structures that are distressed because of inadequate design.

A more cost effective alternative for both new and remedial construction may be to use a **compressible inclusion** to allow the structure to move yet transmit a **reduced magnitude** of displacement to the retained soil.

RMAX GeoFoam® is cost effective and particularly well suited for both earth volume changes and structural movement.



RMAX GeoFoam® Civil Construction Applications

RMAX GeoFoam® for use in road construction

As Australia's population continues to rapidly expand, the need for the construction of new roads and supporting infrastructure will ultimately follow suit. Ever increasing pressure for lead time reductions for these construction projects, especially in heavily populated urban areas, necessitates the need for highly innovative non traditional building materials such as RMAX GeoFoam® to be used.

Traditional road construction over soft or loose soils presents unique engineering challenges. Low quality soils may be incapable of supporting the projected traffic loads in the area where the road is planned to be constructed. In situations such as these, Designers / Engineers must apply the use of innovative materials and construction techniques in order to address the problem of building on soft soils or where sensitive existing utilities or wetlands may be present, while, at the same time, ensuring that they meet ever more demanding project schedules.

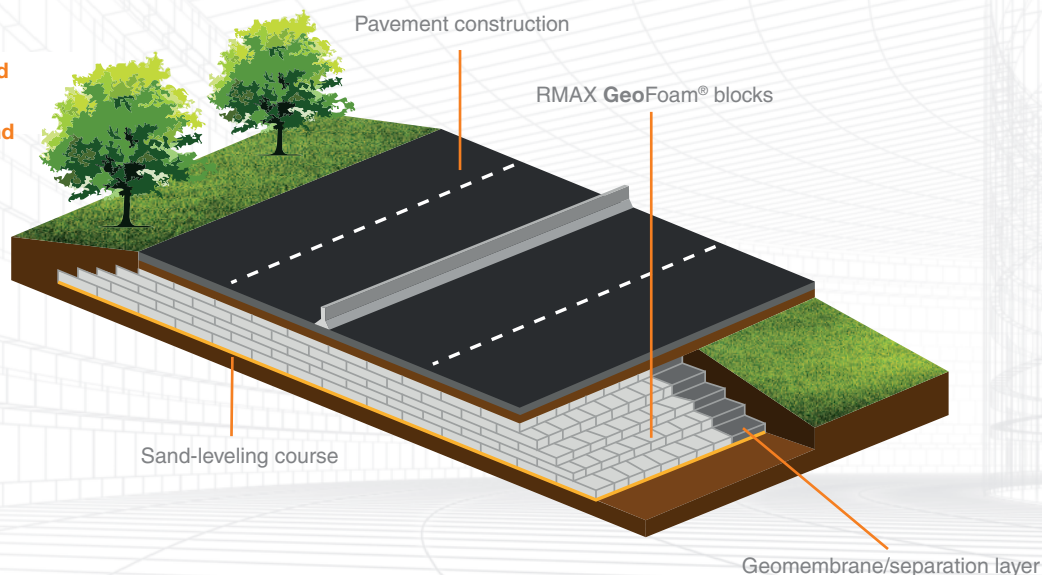
RMAX GeoFoam® is an ideal material for application in these situations as it can be used to replace compressible soils or in place of heavy fill materials to prevent excessive loading on the underlying ground and adjacent structures. The high compressive stress resistance of RMAX GeoFoam® makes it an ideal material to adequately support the high traffic loadings associated with new road constructions.

Furthermore, road construction undertaken using RMAX GeoFoam® will also save in overall construction time because RMAX GeoFoam® is easy to handle, transport and install without the need for special heavy equipment. Most importantly the project completion time can be significantly reduced because the RMAX GeoFoam® material once laid, can be built upon immediately, without the need to wait for compaction and settling time that would normally be required when using most traditional fill materials.

A description of a typical road construction, using RMAX GeoFoam® from 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.
- Lay the RMAX GeoFoam® blocks down in a layer upon layer configuration until the desired height is reached, staggering the vertical joints in each course so as not to create continuous vertical seams.
- The RMAX GeoFoam® blocks are laid following the same construction principle as traditional lay up patterns of bricks and mortar for residential and commercial building construction providing the greatest stability and strength.
- If required, a separation layer may be placed between the top of the RMAX 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 RMAX GeoFoam® both during and after construction.
- There are a number of suitable materials that can be chosen as the separation layer including geotextile, hydrocarbon resistant geomembrane, geogrid, and geocell with soil fill, soil cement, or a reinforced concrete slab.

Cross section of road construction using RMAX GeoFoam® and overlying pavement system



RMAX GeoFoam® Civil Construction Applications

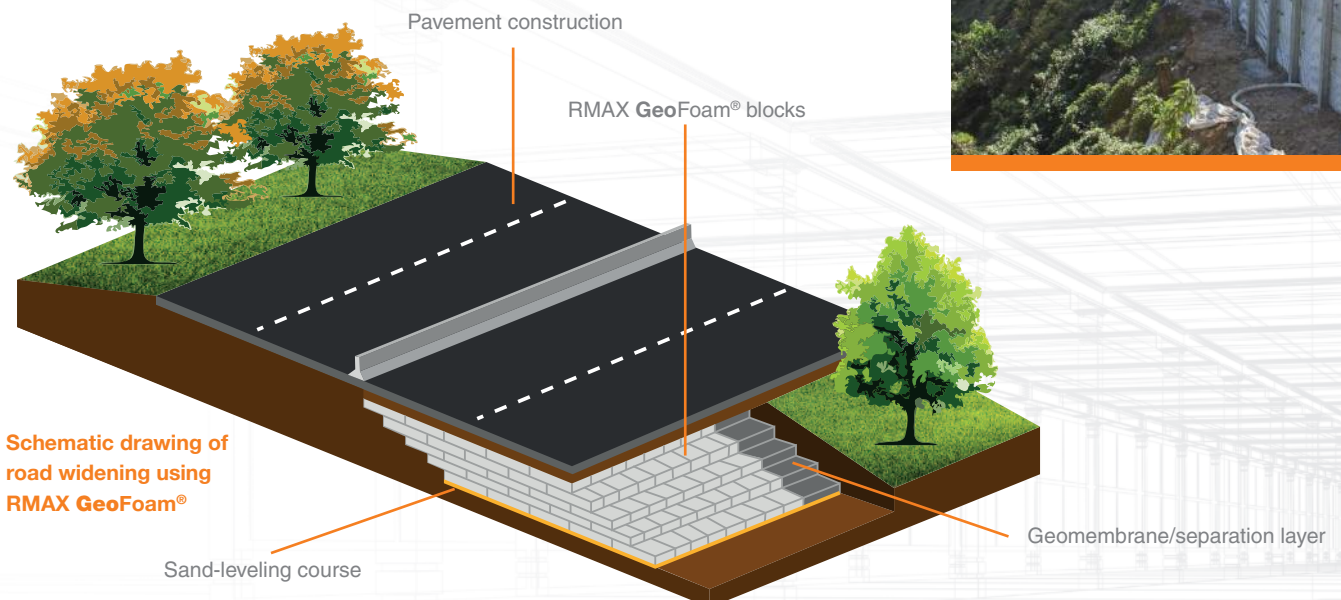
RMAX GeoFoam® application in road widening

Existing roads often require widening as population growth over time results in increased traffic density and congestion. This increased congestion becomes too much for the existing road infrastructure to handle. The requirement for roadways to be widened often necessitates the need for fill to build up the existing shoulders of the road. This process can be expensive and very time-consuming if the soil or ground cover adjacent to the existing roadway is deemed not to be able to support the newly projected traffic loads.

In traditional road construction, soil embankments are built in thin sections or lifts, each of which must be compacted before the next lift is placed. This process is very laborious and takes a significant amount of time to properly complete. Using RMAX **GeoFoam**® eliminates the need for compaction and settling. RMAX **GeoFoam**® also negates the need for off site fill testing which in turn greatly reduces the construction time and minimizes impact to the existing roadway and adjacent structures and/or buried utilities. The high compressive resistance of RMAX **GeoFoam**® makes it able to withstand the induced traffic forces without causing unacceptable loading of the underlying soils or adjacent fill.

As an example of where RMAX **GeoFoam**® has been used specifically for a road widening project is the Mt Ousley Acceleration Lane Project in NSW, whereby 1000 cubic metres of RMAX **GeoFoam**® were used in place of traditional fill materials to create a foundation for extra traffic lanes to be built upon. Sitting some 30 metres above the valley floor, Mt Ousley Road is the main connection between Sydney and Wollongong. Over 10,000 vehicles use the main road everyday.

To ensure that drivers could safely merge on to this fast flowing artery, the acceleration lane needed to be much longer and slightly wider than originally designed. The solution was to fix galvanized pilings directly into the face of the valley and fill the void with RMAX **GeoFoam**®, (as per the adjacent photos). Once the 1000 cubic metres of RMAX **GeoFoam**® was laid in place, the construction was then able to be covered with over 1200 tonnes of lean mix concrete. RMAX **GeoFoam**® was selected and applied as the fill material on the Mt Ousley job site because of its high strength to weight ratio which ultimately reduced the resultant stresses on the structure.

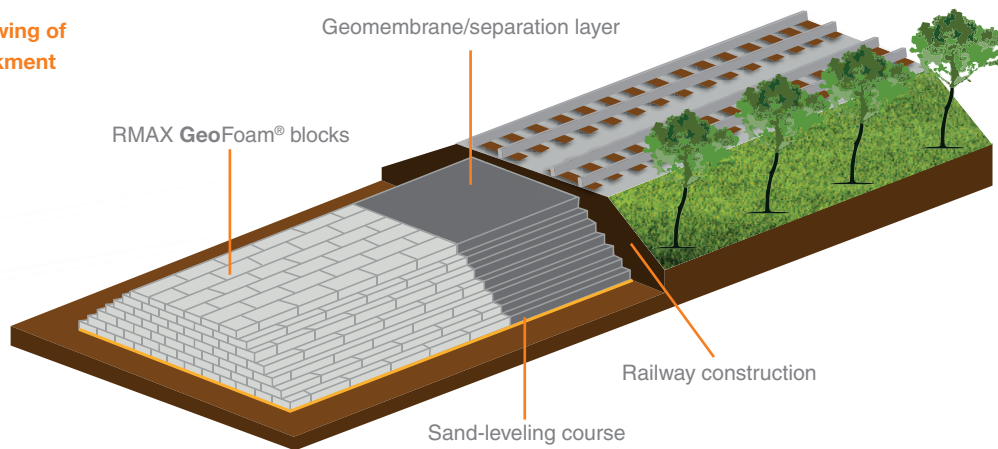


RMAX GeoFoam® Civil Construction Applications

RMAX GeoFoam® application in airport runway/railway construction

As with the application of geofoam in road construction and widening, RMAX GeoFoam® can also be used as the foundation for the construction of airport runways to replace unsuitable ground cover without overloading the underlying subgrade materials. The high compressive strength of RMAX GeoFoam® can be used in this application, to control settlement on the highly compressible and saturated soils and to prevent differential settlements at the intersection of new and existing pavements. This principle is also applied to foundation construction of rail road lines greatly reducing the likelihood of settlement and supporting the inherent loads of the rail lines and trains that travel on them.

Schematic drawing of railway embankment

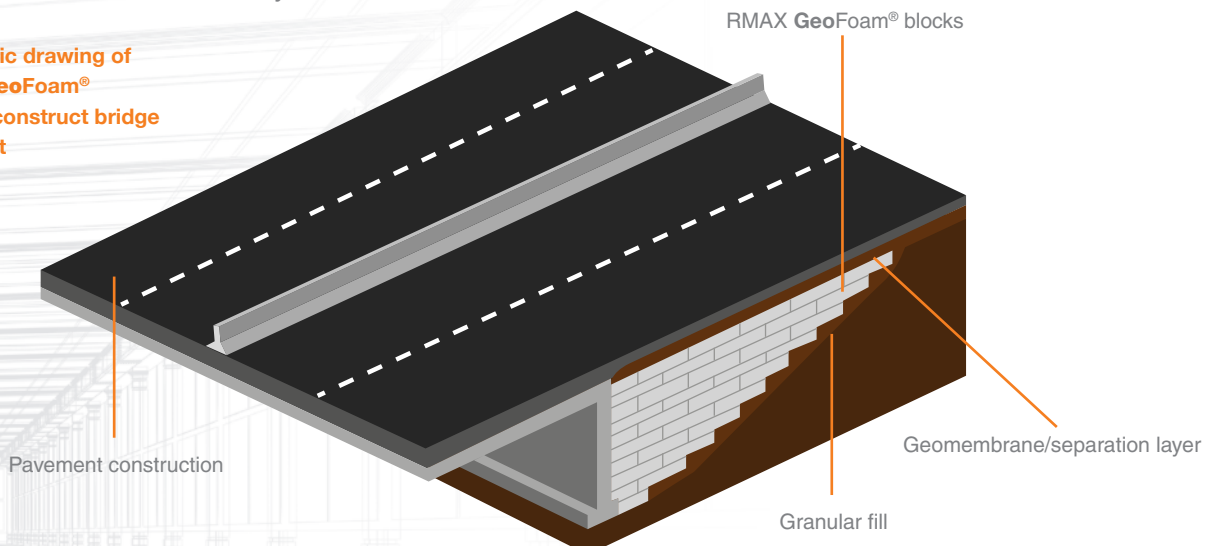


RMAX GeoFoam® in bridge abutment construction

There are several advantages to using RMAX GeoFoam® to construct approach fills for bridge abutments. Because of its high compressive resistance, RMAX GeoFoam® can safely support the combined live and dead loadings associated with these types of constructions without over-stressing the underlying ground cover.

The use of RMAX GeoFoam® in bridge abutment construction usually results in less differential movement at the bridge/approach fill interface. In addition, when compared to traditional embankment fills, RMAX 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 applied. If this weight is able to be substantially reduced, as would be the case where RMAX GeoFoam® backfill is applied, this can lead to simpler, less expensive bridge abutment design, as the bridge walls are no longer required to resist large horizontal static and dynamic forces that would normally be present with the use of traditional soils or other heavy fill materials.

Schematic drawing of RMAX GeoFoam® used to construct bridge abutment



RMAX GeoFoam® Civil Construction Applications

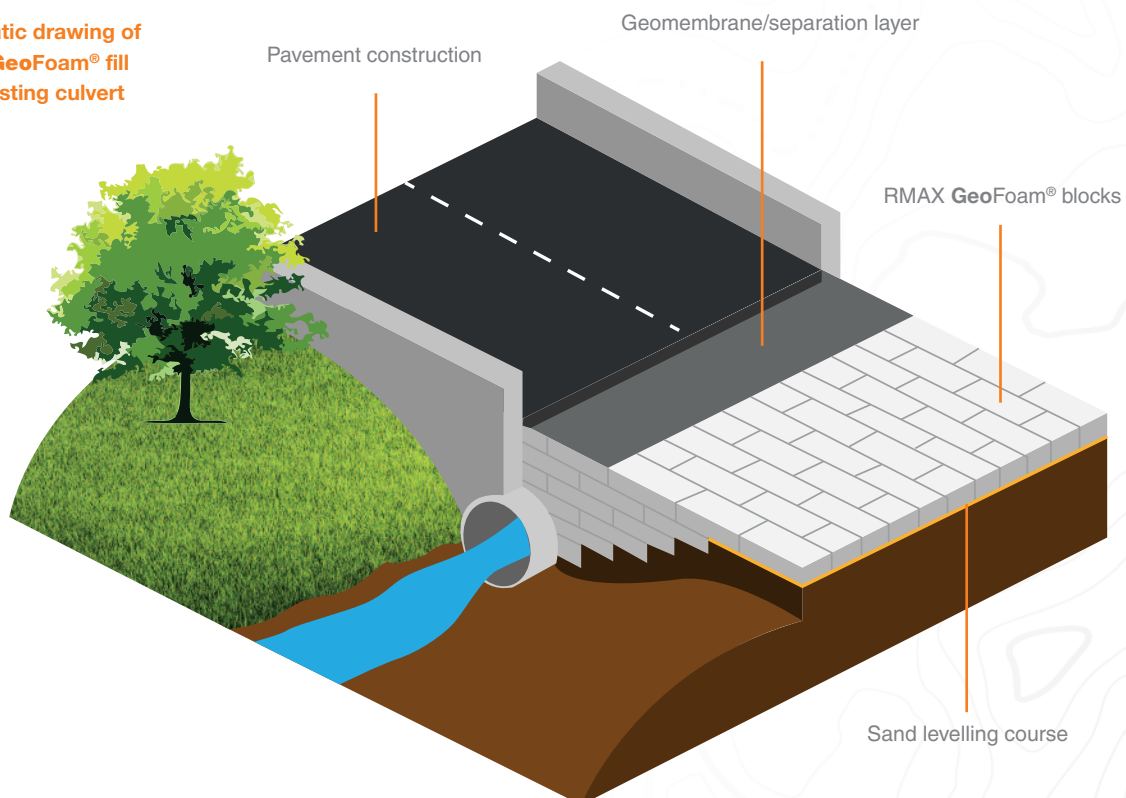
RMAX GeoFoam® for culverts, pipelines and buried structures

In situations where a new road, bridge or tunnel construction etc. is slated to pass over areas where existing piping or other buried infrastructure may be present, the engineering design plans will often call for the placement of new fill over the existing underground structures to facilitate the new construction. This common situation creates design challenges as the existing piping and infrastructure that is intended to be buried, may not have been designed to accommodate the increased loads when it was originally specified and installed.

Rather than having to strengthen or completely remove the existing underground structures, the load bearing requirements can be reduced to a safe level by using RMAX **GeoFoam**® as the fill material instead of heavier traditional fills.

The use of RMAX **GeoFoam**® in applications such as this again provides significant savings as the existing infrastructure now no longer needs to be either completely removed and replaced or removed and modified to be able to cope with the increased loads. As with road construction, the use of RMAX **GeoFoam**® provides significant savings as it is easy to handle, transport and install without the need for special equipment. Most importantly the project time can be significantly reduced by virtue of the fact that the RMAX **GeoFoam**® material once laid, can be built upon immediately, without the need to wait for compaction and settling that would normally be the case when using most traditional fill materials.

**Schematic drawing of
RMAX GeoFoam® fill
over existing culvert**



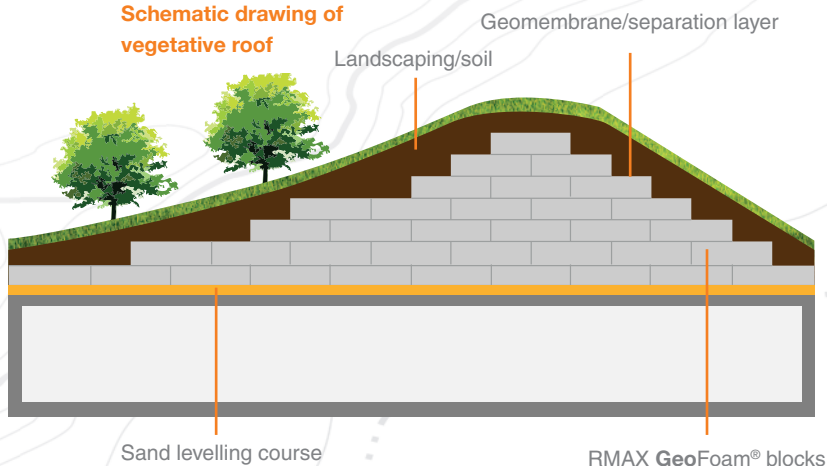
RMAX GeoFoam® Civil Construction Applications

RMAX GeoFoam® used for landscaping design

RMAX GeoFoam® can be used to create unique landscape designs. This can be done by the building up of block layers and the ability of the RMAX GeoFoam® to be cut into numerous intricate shapes and profiles on site or for the blocks to be delivered already pre cut to the desired profile. The application of RMAX GeoFoam® allows complex landscape designs to be created without adding significant loads to the underlying structures and services. Some examples of this application include creating design elements for golf courses and public parks and creating unique landscapes for stages to be built upon for concerts and other live events.

An example of where RMAX GeoFoam® was recently used in a project to create a unique landscape which was capable of supporting a large constructed stage was for the Madama Butterfly Opera stage creation in NSW. RMAX GeoFoam® was ideal for this application because it was able to be cut or trimmed on site quickly and easily in order to fit the odd geometries and created a unique man made architectural profile for the intricate stage design as shown in the photos opposite. A series of interesting geometric shapes were able to be created with little additional load having to be applied to the underlying structures.

Schematic drawing of vegetative roof



784 CAD-cut pieces of RMAX GeoFoam® were used to create the floating stage



Once in place, the RMAX GeoFoam® provided a base upon which an elaborate stage set was built

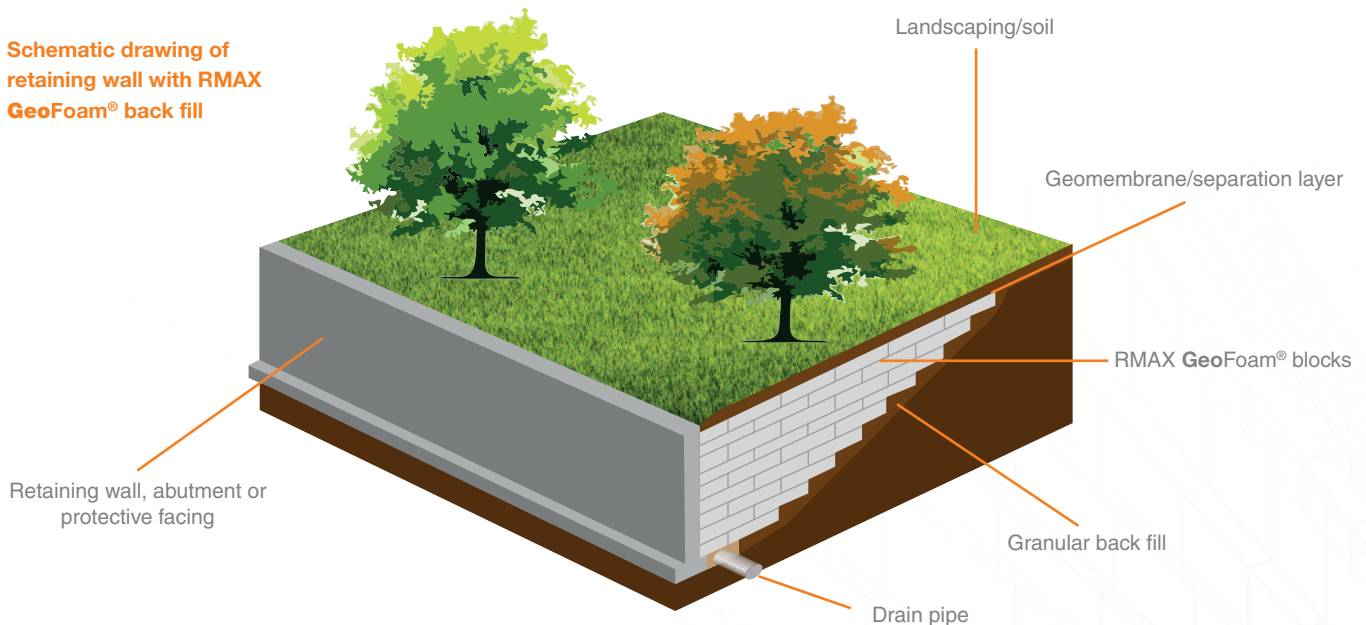
RMAX GeoFoam® Civil Construction Applications

RMAX GeoFoam® use in retaining and buried wall backfill

RMAX GeoFoam® can be used as light weight backfill behind retaining and buried structures to greatly reduce lateral pressures that would normally act on the structure with traditional fill materials. Because the horizontal pressures acting on a retaining wall are directly proportional to the weight of the backfill material used, the use of RMAX GeoFoam® as the backfill results in the ability to greatly reduce the horizontal loads applied resulting in the implementation of a thinner or less complex retaining wall design. This in turn enables project cost and time savings to be realised.

Likewise, the use of RMAX GeoFoam® backfill behind retaining and buried structures also limits the horizontal forces that can develop during earthquakes assisting in preservation of the structural integrity of the construction when subjected to these forces. Retaining wall applications constructed in low lying areas, where shallow groundwater and loose soils may exist, require that adequate drainage mechanisms be considered as part of the design to prevent the potential for development of hydrostatic pressure which could cause uplift displacement of the geofoam blocks.

Schematic drawing of retaining wall with RMAX GeoFoam® back fill

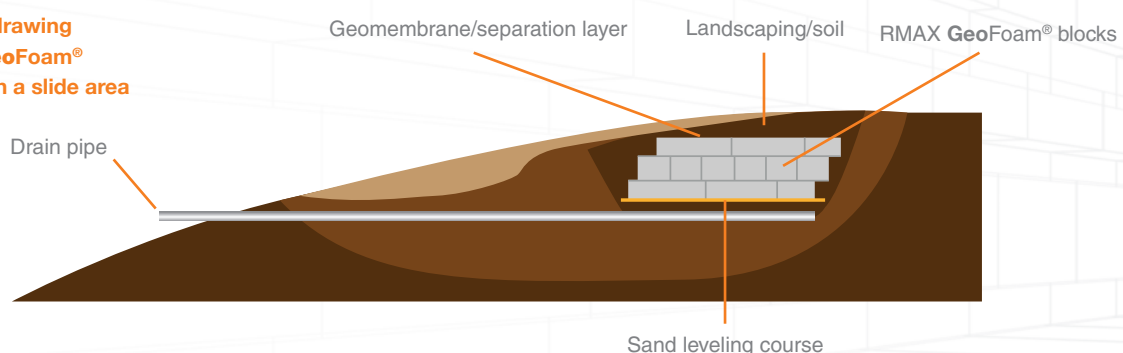


RMAX GeoFoam® use in slope stabilisation

RMAX GeoFoam® can be used to remediate either man made or naturally occurring unstable slopes by removing a portion of the existing loose unstable soil and replacing it directly with RMAX GeoFoam® fill. The application of RMAX GeoFoam® improves the slopes overall stability and ensures that the potential for landslides occurring in the area of the slope due to excessive rain or other natural events, is greatly reduced by improving its overall structural stability.

Slope stability analysis can be undertaken to determine the volume of RMAX GeoFoam® required to replace the existing soil. Undertaking this analysis leads to significantly improved factors of safety against future soil destabilisation which in turn can lead to land slides.

Schematic drawing of RMAX GeoFoam® placement in a slide area



RMAX GeoFoam® Civil Construction Applications

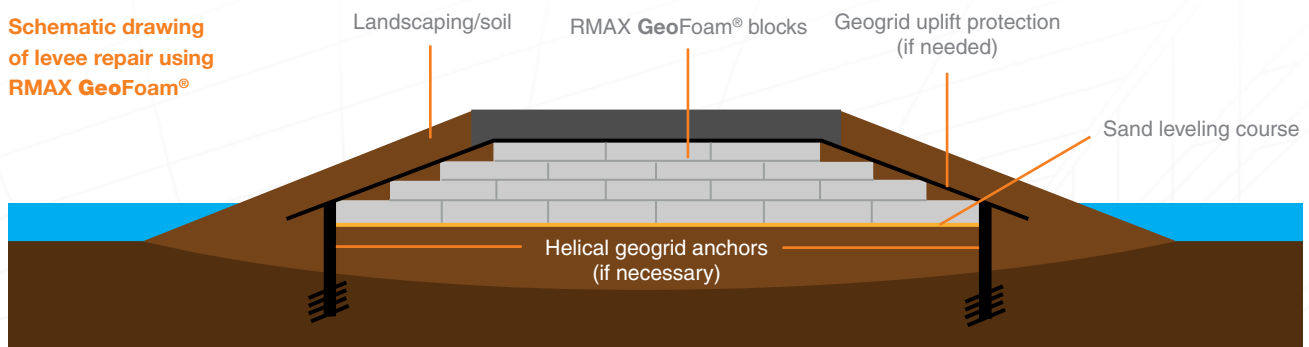
RMAX GeoFoam® use in levee construction design

Levees are frequently built on compressible alluvial soils along river banks to provide suitable flood mitigation protection. These compressible and water saturated soils undergo settling over time due to continued compression. Soil settlement and or erosion are continuous natural processes that occur on and around river banks. Traditionally river levees have been constructed using conventional soils that are present in the surrounding land areas around the river. The extra weight from the levee construction and any re-raising using these traditional soils causes additional settlement over time due to the added weight and the cycle of soil settlement.

With the use of RMAX **GeoFoam®**, this cycle of levee build up and settlement can be greatly reduced or even eliminated, resulting in the levee/s only needing to be newly constructed or reconstructed once, with minimal maintenance needed thereafter. RMAX **GeoFoam®** having approximately 1% of the weight of traditional soil fills, reduces/eliminates additional stress when used in lieu of traditional soil fill and in doing so, the cycle of soil settlement and levee collapse, is able to be stopped.

The process of levee rebuilding using RMAX **GeoFoam®** is done so by removal of a portion of the existing levee. The removed soil can be stockpiled for reuse as cover for the RMAX **GeoFoam®** once all blocks have been laid. Once the existing levee is removed RMAX **GeoFoam®** blocks are placed on a sand-levelling bed and a geomembrane cover is used to encapsulate the blocks. A geotextile is then placed over the geomembrane and the previously excavated soil is then re-laid and compacted over the RMAX **GeoFoam®** to bring the levee to its desired elevation. These same construction principles can also be applied to the construction of a new levee.

Schematic drawing of levee repair using RMAX GeoFoam®



RMAX GeoFoam® Civil Construction Applications

RMAX GeoFoam® use in compensating foundations and foundations for lightweight structures

RMAX **GeoFoam®** can be used in areas where the underlying soil condition is deemed unsuitable for the support of civil and or residential building constructions that would transmit high load bearing stresses, which the ground cover may not be able to withstand.

In situations such as these, RMAX **GeoFoam®** can be installed to act as a compensating foundation, reducing the overall load on the underlying compressible soils and minimizing 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”. An example of this would be land that is intended to be used for civil or residential construction that happens to be near a large water body such as a lake or river.

Another innovative use of RMAX **GeoFoam®** is to replace traditional agricultural pile footings on peat soils. The advantages of using RMAX **GeoFoam®** for the footings are its light weight, the ease of construction and the ease of transportability for reuse where required, resulting in significant project cost savings.

RMAX **GeoFoam®** footings can be designed to impart a net zero load on the underlying ground cover which in applications such as this, is usually highly compressible peat soils. The total applied load, which is made up of the footings, the weight of the structure as constructed, the lateral wind loads that would be experienced and an engineering safety factor, can be translated into the volume of soil that will need to be removed and replaced by RMAX **GeoFoam®** footings to produce an overall net zero load applied.

RMAX GeoFoam® use in tiered seating applications for stadiums & theatres

RMAX **GeoFoam®** can also be used in some specialist, non traditional civil applications such as the construction of tiered seating in various public venues such as auditoriums, sports complexes, movie theatres, gymnasiums, churches etc. The high compressive resistance and light weight characteristics of RMAX **GeoFoam®** make it well suited to both new construction projects and for renovation of existing structures where applicable.

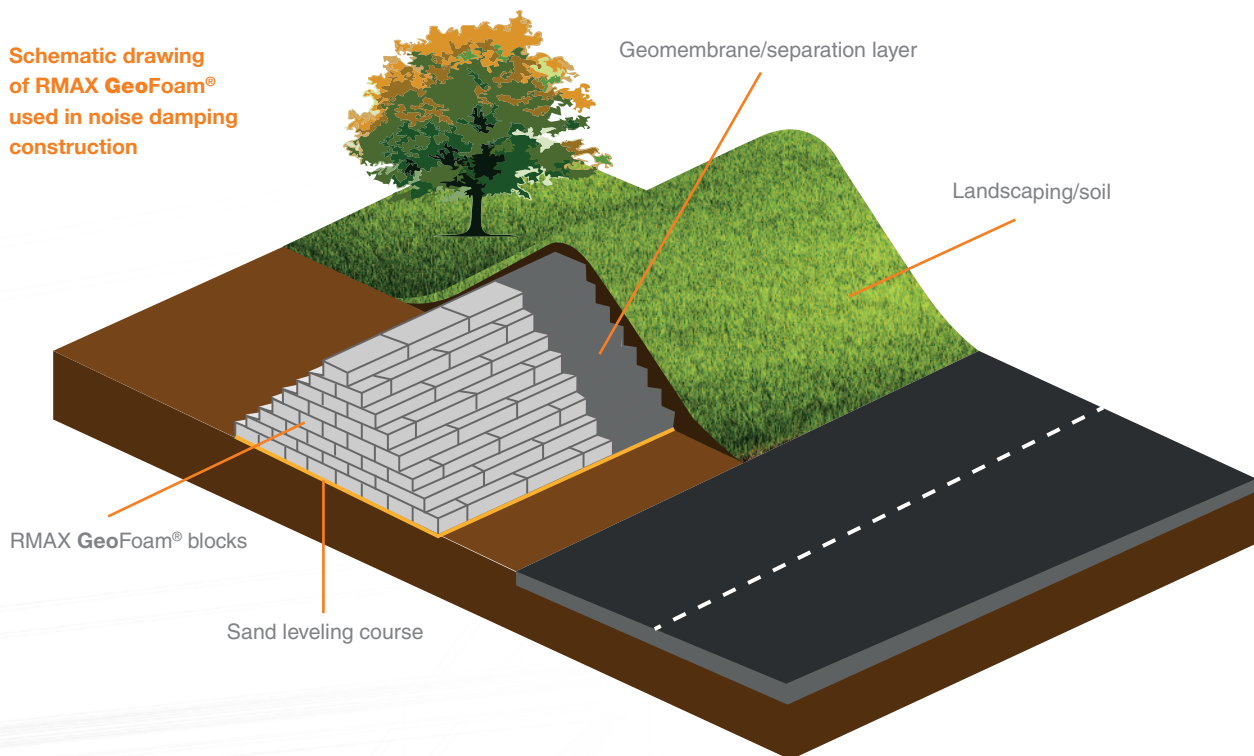
For these specialised projects, RMAX **GeoFoam®** blocks can be fabricated and then stacked to specific heights to create the desired profiles for each of the tiers. Fascia riser screeds can then be applied to the front of the RMAX **GeoFoam®** blocks to provide support and formwork for the placement of finished concrete treads. Seats, bleachers, other attachments and finishes are then able to be directly attached to complete the tiered seat construction.



RMAX GeoFoam® Civil Construction Applications

RMAX GeoFoam® use in noise and vibration damping applications

RMAX GeoFoam® can also be used to build free-standing sound absorbing high walls or embankments to reduce noise transmission in urban areas from road traffic on highways and freeways. RMAX GeoFoam® can also be used to reduce the transmission of ground borne vibrations, for example, under railways or pavements, as part of the foundation of adjacent structures or as a cut off wall between the railways or pavements and the adjacent structures.



RMAX GeoFoam® Construction Principles

In most applications, long term design loads should not exceed the linear elastic range of RMAX GeoFoam®. Combined live load and dead load stresses should not exceed the compressive resistance at 1% strain.

General

The bottom of the installation of an RMAX GeoFoam® should be above the mean height of the water table. If there is any possibility of flooding the buoyancy effects must be considered. Common methods to counteract buoyancy are the use of sufficient overburden or use of mechanical constraint. Suitable drainage measures must be taken; on sloping sites this is particularly important.

1. Supporting layers

The bottom layer of the RMAX GeoFoam® installation has to be supported over its entire lower face, so a plane surface, inclined as appropriate, must be prepared. Departures from planarity should not exceed (± 1 cm in 400 cm). The material used is generally sand, its thickness depends on the ground and the machines to be employed.

2. Construction of RMAX GeoFoam® Installations

The RMAX GeoFoam® installation must be laid flat, with staggered joints; no voids or open joints may be left. The joints must be offset by at least 50 cm. Where there is more than one layer of RMAX GeoFoam® blocks alternating layers of RMAX GeoFoam® should be staggered. To prevent displacement of blocks during construction they should be fixed together at intervals with polyurethane-based adhesive or mechanical fasteners (e.g. barbed dowels, diameter 117 mm at distances of 1–2 m).

Any water at or near the ground surface must be pumped off until the RMAX GeoFoam® installation is covered by material whose weight is sufficient to prevent floatation. RMAX GeoFoam® does not swell when exposed to water or water vapour.



RMAX GeoFoam® Construction Principles

3. Construction above the RMAX GeoFoam® installation

As a rule, the sub-grade of the road distributes the load and protects the RMAX GeoFoam® installation, while its surface constitutes the road formation. During construction it is important to protect the RMAX GeoFoam® from damage from traffic - this can be done by having an adequate thickness of suitable materials, such as concrete over the RMAX GeoFoam®. Loads are spread particularly well by reinforced concrete slab, 12–15cm thick, formed in situ, otherwise strengthened layers of other suitable materials may be used instead. **Traffic in direct contact with RMAX GeoFoam® foam blocks is not permissible.**

The construction of the pavement above road formation accords with usual practices and rules, but to allow adequate compaction the thickness of material in contact with the upper surface of the EPS block or of the concrete slab over it should not be less than 30 cm.

4. Embankment Slopes

The stepped sides of the installation of RMAX GeoFoam® blocks must be bounded by planes whose slopes are consistent with stability, the required profile, the covering material, and the kinds of vegetation intended.

The depth of soil covering the sides may not be less than 25 cm, measured normally to the planes bounding the installation of RMAX GeoFoam® blocks. If slopes greater than 1:1.5 are proposed and soil-mechanical considerations allow them, the soil should be secured against slip by appropriate measures, such as reinforcement with geotextiles or gabions. Where the sides of the embankment are to be greened by other than shallow-rooted plants, the soil covering over the RMAX GeoFoam® installation must be deep enough to allow the roots to provide adequate anchorage.

5. Subsidiary highway components

If the depth of material covering the top of the RMAX GeoFoam® installation EPS core is 1.50 m or more, no special arrangements need be made for anchoring subsidiary components such as safety fences, direction signs, etc. Depths of less than 1.50 m necessitate provision of concrete anchor blocks, which can be factory-made components resting on the load-spreading course or cast in situ in EPS forms.

Cables can be laid within the EPS if necessary provided the ducts or channels required are bridged in such a way that the load-bearing capacity of the whole system is not adversely affected. Work involving welding or soldering will not be permissible.



RMAX GeoFoam® Construction Principles

Anchoring of RMAX GeoFoam®

Due to RMAX **GeoFoams**® closed-cell structure and its inherent light weight characteristics, RMAX **GeoFoam**® is a buoyant material. As such, care must be taken during design, construction and post-construction to ensure that any potential for the development of hydrostatic forces have been taken into account within the existing hydrological conditions of a given site. Adequate surcharge, i.e., soil or pavement cover, or an alternate means of passive RMAX **GeoFoam**® block restraint such as physical ground anchoring of the RMAX **GeoFoam**® blocks must be provided to counter against the potential for hydrostatic uplift of the RMAX **GeoFoam**®.

RMAX GeoFoam® block layout

When installing RMAX **GeoFoam**® blocks on site, regardless of application type, it is recommended to stagger the vertical block joints of each block course so as not to create continuous vertical seams. The build up of RMAX **GeoFoam**® block layers is done in exactly the same way as the construction of a brick wall with staggered vertical joints as per the diagram below.

RMAX GeoFoam® ease of handling and installation

Due to its light weight character, no unique equipment is required for construction with EPS geofoam. Depending on application, blocks can often be carried and safely set in place with inexpensive mechanized equipment. This is an important consideration when the construction site is congested with other services or does not have the clearances required for traditional use of compaction and other specialised equipment. RMAX **GeoFoam**® can be easily cut to shape on site using a hot-wire cutter or hand saw etc., where required to accommodate existing underground utilities and services that may be present in a given application.

Construction time & cost savings using RMAX GeoFoam®

The use of RMAX **GeoFoam**® assists in achieving ever tightening project construction schedules. The ease and speed with which RMAX **GeoFoam**® blocks can be installed, results in shorter construction times due to faster placement rates and reduced utility relocation.

Compared to traditional construction methods and depending on application type, for road and rail line construction, bridge abutment etc, the use of RMAX **GeoFoam**® negates the need for compaction of the soils and having to wait for settlement to occur.

Traditional soil fills are constructed in small sections with repeated compaction. This requires considerable time, the use of heavy construction equipment, increased costs in fuel and labour to operate the equipment and the requirement for field testing to ensure adequate compaction of the soils. For soft soil conditions, significant waiting time is required after fill placement while the underlying foundation soil consolidates and settles. In contrast, RMAX **GeoFoam**® can be quickly laid in place with no need for compaction or waiting for consolidation or settling to occur. Geofoam can effectively be laid and built upon straight away.

Although RMAX **GeoFoam**® may be more expensive than most traditional fill materials on a cost per cubic metre basis, the extra cost of the RMAX **GeoFoam**® is usually completely offset by considerable savings in reduced labour and the elimination of processes requiring the use of heavy machinery such as soil compaction. The use of RMAX **GeoFoam**® also reduces the need for maintenance and where maintenance is required, it helps to increase the minimum time frames between the maintenance intervals.

RMAX GeoFoam® Design Considerations

RMAX GeoFoam® chemical exposure

As RMAX GeoFoam® can be used in a wide variety of civil and other applications, there may be instances in certain applications where RMAX GeoFoam® may be subjected to chemical exposure. This can be either by direct exposure to the chemicals themselves or to the vapours that the chemicals may give off.

The potential for exposure to chemicals will most commonly occur during installation of the RMAX GeoFoam® on site or as a result of contaminated site conditions that may occur after the RMAX GeoFoam® has already been installed.

The below table provides general guidance for the resistance of RMAX GeoFoam® to a number of chemicals. The table is intended to provide a preliminary guide only and does not guarantee long term performance of RMAX GeoFoam® when in contact with the listed or any other chemicals.

It is recommended that laboratory tests modelled to represent chemical exposure in end use conditions, be conducted to assure efficacy of the RMAX GeoFoam® in the chosen application.

If the exposure of RMAX GeoFoam® to any harmful chemicals is a possibility or in doubt, the protection of RMAX GeoFoam® by means of an appropriate barrier material is required. An example of where this would be applicable is in the case of a road construction application where RMAX GeoFoam® has been used as the material fill layer that the road is constructed on. If there were to be a vehicular accident which could cause petrol (benzene), motor oil, brake fluid, (glycol ether) radiator coolant (glycol) or other chemicals to be released, these chemicals could seep through the various ground layers and eventually come into contact with the RMAX GeoFoam® sub structure.

S=Satisfactory M=Marginal* U=Unsatisfactory*

Chemical	Rating	Chemical	Rating
Acetic Acid (5%)	S	Isopropyl Alcohol	M
Acetic Acid (10%)	M	Methyl Alcohol	M
Acetone	U	Methyl Ethyl Ketone	U
Ammonia	S	Mineral Oil	S
Benzene	U	Motor Oil	M
Butyl Alcohol	S	Nitric Acid (20%)	U
Citric Acid (10%)	S	Paint Thinner	U
Citric Acid (20%)	M	Petroleum Jelly	S
Detergents	M	Potassium Hydroxide (%30)	S
Diesel Fuel	U	Propyl Alcohol	M
Ethyl Acetate (98%)	U	Propylene Glycol	S
Ethyl Alcohol (95%)	M	Sodium Chloride (saturated)	M
Ethylene Glycol	S	Sodium Hypochlorite (15%)	S
Gasoline	U	Sodium Hydroxide (40%)	S
Hexane	U	Sulphuric Acid (50%)	S
Hydrochloric Acid (10%)	S	Sulphuric Acid (96%)	S
Hydrochloric Acid (38%)	M	Toluene	U
Hydrochloric Acid (100%)	U	Turpentine	U
Hydrogen Peroxide (30%)	S	Water (salt/sea)	S
		Xylene	U

RMAX GeoFoam® must be protected by an appropriate geo-synthetic textile membrane barrier material, if there is any potential for exposure to these chemicals either during installation or during the materials serviceable life. In selecting a suitable geotextile you must ensure its compatibility with RMAX GeoFoam® prior to application. There are a number of hydrocarbon resistant geotextile membranes that are suitable for protection of RMAX GeoFoam® that could be used. Some examples of compatible geomembranes are polypropylene, polyethylene, chlorosulphonated polyethylene (CSPE) and Ethylene Interpolymer Alloys (EIAs).

PLEASE NOTE: As the above information is a guide only, you should always consult with a qualified geotechnical engineer or specialist geotextile membrane supplier, as to the most suitable membrane for a given application which ensures compatibility with the RMAX GeoFoam® product.

RMAX GeoFoam® Design Considerations

RMAX GeoFoam® compressive resistance

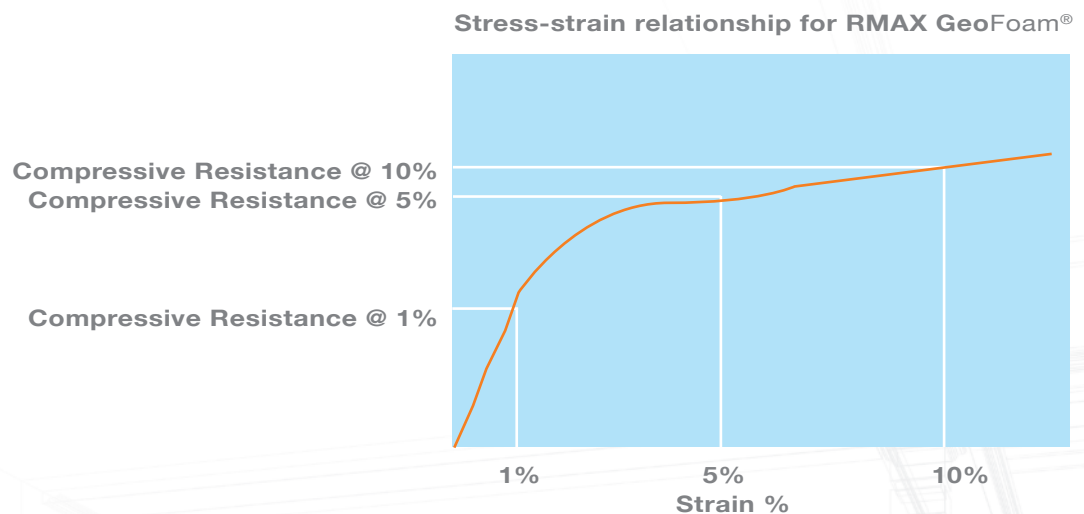
RMAX GeoFoam® is a low density (12kg/m^3 to 38kg/m^3) and high strength-to-weight ratio material that has the capacity to withstand and dissipate enormous forces. Its cellular structure provides tremendous structural integrity and when installed correctly can reduce loads (as a result of low density/weight ratio) and reduce stress (due to the compressible inclusion function) on unstable sites by up to 95%.

EPS behaves as a linear elastic material up to a strain rate of approximately 1%. Thus the design recommendation for RMAX GeoFoam® is to limit load bearing capacity to the maximum compressive resistance as measured at 1% strain. The stress at a compressive strain rate of 1% is called the elastic limit stress.

Except for special compressible inclusion application requirements, higher compressive strain, typically 5% or 10%, is not used to estimate the EPS strength because these strains are past the ultimate yield strength of the EPS and this may lead to undesirable permanent strains.

RMAX GeoFoam® creep behaviour

The as tested creep behaviour of EPS is minimal at strain levels below 1%. The effects of creep increase significantly at higher strain rates of 5% and 10% as typically tested. This is one of the primary reasons for using a compressive resistance at maximum 1% strain for load bearing design applications of RMAX GeoFoam®.



RMAX GeoFoam® lateral resistance (Coefficient of Friction)

The lateral resistance of RMAX GeoFoam® is based on the inherent friction that exists between layers of blocks that are in direct contact with one another, unless some special design (such as adhesives or shear keys) are used to join the blocks.

The coefficient of friction, μ , between RMAX GeoFoam® blocks along moulded faces is **0.5**. It is higher along cut faces where there is increased surface roughness. The coefficient of friction for a wire cut face can be assumed to be the same as a moulded face or **0.5**.

RMAX GeoFoam® Design Considerations

RMAX GeoFoam® load distribution: (Poisson's Ratio)

The Poisson's ratio for RMAX GeoFoam® is approximately 0.12 within the elastic range.

RMAX GeoFoam® load bearing strength characteristics

RMAX GeoFoam® is available in a range of compressive resistances based on the manufactured RMAX GeoFoam® block density. A project designer can choose the specific type of RMAX GeoFoam® required to support the design loading (live and dead loads combined) while minimising cost. Different RMAX GeoFoam® densities can be specified on a single project to maximise savings. For example, higher density, higher strength RMAX GeoFoam® can be used in areas where there is high applied stress while lower density, lower strength blocks can be used in areas where the applied stresses are lower. To avoid the possibility of incorrect density block placement, blocks can be pigmented as required as a means to differentiate the various block density grades. Pigmenting the RMAX GeoFoam® blocks, also assists in reducing glare from the traditional RMAX GeoFoam® white blocks on sites with very high rates of sun exposure.

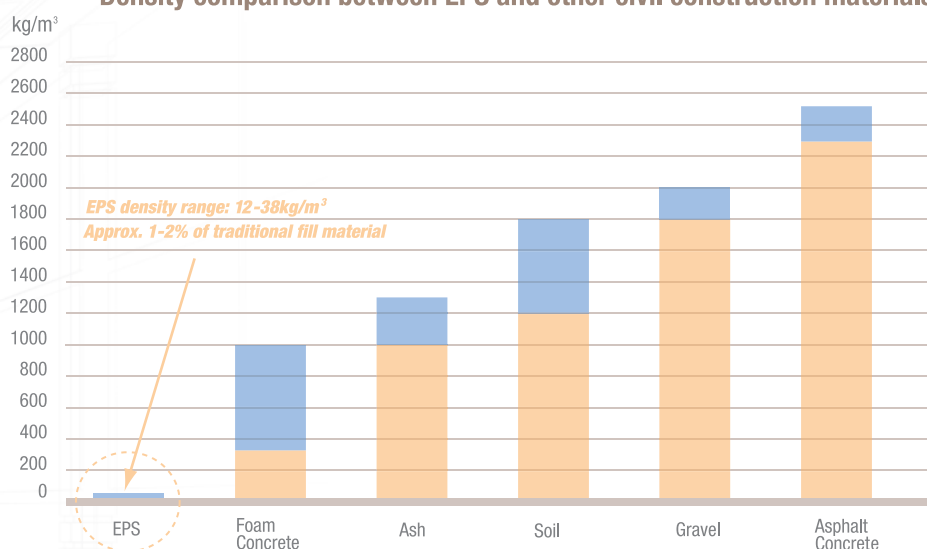
It is recommended that the RMAX GeoFoam® design loads do not exceed the maximum compressive resistance at 1% capacity. This limit controls the amount of long-term deflection, or creep, resulting from permanent sustained loads that the RMAX GeoFoam® would be subjected to in service. The maximum RMAX GeoFoam® compressive strength increases with increasing density, therefore allowing the selection of the most appropriate density for a given load bearing application. Note: Adequate soil cover, or a load distribution slab, may be required to distribute large concentrated point loads in a given application.

RMAX GeoFoam® lightweight characteristics

RMAX GeoFoam® can be manufactured in various densities ranging from 12g/l through to 38g/l and in weights that typically range from approximately 12kg/m³ to 38kg/m³. As a result, of this very light weight per unit area characteristic, the RMAX GeoFoam® blocks end up imparting negligible dead loads or stresses to underlying soils, structures and utilities. This is advantageous where the existing soils may be poorly suited to support additional loading requirements (e.g., compressible clay, peats, etc.). Existing loads can be significantly reduced by excavating and replacing native soils which commonly weigh upwards of 1.5 tonnes per cubic metre, with RMAX GeoFoam® which, even in its heaviest form weighs a small fraction of this.

Furthermore the replacement of heavy density soils with RMAX GeoFoam® assists in eliminating the need for specialised foundations or site preloading to reduce settlement and improve bearing capacity. Additionally, the use of RMAX GeoFoam® over existing utilities can eliminate the need for utility removal, relocation or redesign.

Density comparison between EPS and other civil construction materials



RMAX GeoFoam® Design Considerations

RMAX GeoFoam® California Bearing Ratio (CBR)

The California Bearing Ratio (CBR) determines the resistance of the subgrade material to deformation under the load from vehicles, in other words it measures the inherent strength of the ground or material that a road is going to be built upon (i.e. the layer of naturally occurring or introduced material such as RMAX GeoFoam® upon which the road is to be built).

The CBR value is an important information requirement for civil and road design engineers in determining what material may be applicable for use as a subgrade in road construction.

As the use of RMAX GeoFoam® continues to increase as a preferred material of choice for road subgrade preparation, RMAX has taken the liberty of determining the CBR value for the most popular density grades of its RMAX GeoFoam® product that it manufactures and distributes.

The table below lists the CBR ratio as tested and calculated against a number of popular RMAX GeoFoam® densities. The RMAX GeoFoam® samples were tested both in an as supplied “dry” state and after being fully immersed in water for 96 hours (wet).

RMAX GeoFoam® Grade	CBR Value as tested	RMAX GeoFoam® Test Sample Wet (W) or Dry (D)
RGF2	1.0	D
RGF2	1.5	W
RGF5	2.5	D
RGF5	3.0	W
RGF6	3.0	D
RGF6	3.5	W
RGF9	5.5	D
RGF9	7.0	W

The data in the above table clearly illustrates that the water soaked samples actually performed better in terms of their resultant CBR value. This is advantageous as the sub grade material will be exposed to moisture from rain soak and the presence of ground water, throughout its serviceable life.



RMAX GeoFoam® Design Considerations

The table below lists the typical CBR design values for a range of soil types as measured in the Melbourne area.

Description of Subgrade	Presumptive CBR Value
Extremely poor subgrade conditions <ul style="list-style-type: none"> - saturated basaltic areas - clays of extremely high plasticity (PI>50) - saturated alluvial areas - silty soils subject to saturation 	2
Very poor subgrade conditions <ul style="list-style-type: none"> - clays of very high plasticity (PI 35-50) - disturbed and recompacted Dilurian clays - disturbed and recompacted Tertiary clays and sandy clays of high moisture content - basaltic clay areas not saturated 	3
Silty subgrade soils <ul style="list-style-type: none"> - well drained silty soils 	4
Silty clay subgrade soils <ul style="list-style-type: none"> - silty clay of very high plasticity (PI 35-50) - soils capable of carrying construction traffic (CBR > 5) 	3-5
Plastic sandy clay subgrade soils <ul style="list-style-type: none"> - sandy clay of immediate to high plasticity (PI 15-35) - well drained situations - undisturbed Silurian clays 	3-6
Low plasticity subgrade soils <ul style="list-style-type: none"> - sandy clay of low to intermediate plasticity (PI 10-20) - well compacted silty sandy clay, sandy clay (well drained situations) 	*6-10
Ordovician, Silurian and Devonian Sedimentary Rocks <ul style="list-style-type: none"> - broken and compacted weathered rock 	*6-10

As can be seen from the table above, the RMAX GeoFoam® material densities tested closely match the CBR values of the most commonly found subgrade soils; thus, based on the soil type that is present in a given terrain, a suitable RMAX GeoFoam® density grade can be selected for substitution.



RMAX GeoFoam® Physical Properties

RMAX **GeoFoam®** meets or exceeds the requirements of AS 1366.3 and American Standard ASTM D6817” Standard Specification for Rigid, Cellular Polystyrene Geofoam”. RMAX conducts routine, rigorous testing of RMAX **GeoFoam®** to ensure quality is maintained to these standards.

EPS PROPERTIES: RMAX EPS GeoFoam®

Property / Name	Unit	RGF1	RGF2	RGF3	RGF4	RGF5	RGF6	RGF9	Test Method
Compressive Stress at 10% deformation (min.)	kPa	50	70	85	105	135	165	280	AS 2498.3
Compressive Stress at 2% deformation (min.)	kPa	30	40	60	70	100	115	190	AS 2498.3
Compressive Stress at 1% deformation (min.)	kPa	14	23	30	35	48	55	82	AS 2498.3
Flexural Strength (min.)	kPa	60	150	178	218	304	337	430	ASTM D6817
Elastic Modulus (min.)	kPa	1450	2200	3100	4250	5850	7250	10200	ASTM D6817
Water absorption by total immersion (max.)	Volume %	4.0	4.0	4.0	3.0	3.0	2.0	2.0	ASTM C272
Cross-breaking Strength (min.)	kPa	95	135	165	200	260	320	460	AS 2498.4
Rate of Water Vapour transmission (min.) measured parallel to rise at 23°C	µg/m2.s	710	630	580	520	460	400	350	AS 2498.5
Dimensional Stability of Length, Width, Thickness (max.) at 70°C, dry conditions 7 days	%	1	1	1	1	1	1	1	AS 2498.6
Thermal Conductivity at Mean Temperature of 23°C	W/m.K	0.0427	0.0407	0.0394	0.0380	0.0366	0.0350	0.033	AS 2464.5
Flame Propagation Characteristics:									
Median Flame Duration (max.)	SD	2	2	2	2	2	2	2	
Eight Value (max.)	SD	3	3	3	3	3	3	3	
Median Volume Retained	%	15	18	22	30	40	50	50	AS 2122.1
Eight Value (min.)	%	12	15	19	27	37	47	47	
Bouyancy Force	kg/m³	989	986.5	984	981	976	972	963	

EPS exhibits a very high and predictable compressive strength to weight ratio



RMAX GeoFoam® Physical Properties

RMAX GeoFoam® product stability

RMAX GeoFoam® being made from polystyrene is an inert, organic material that will not rot and is resistant to mould, mildew and fungi. RMAX GeoFoam® is non toxic, odourless and non-irritating to the skin or eyes. It contains no HCFCs and is safe for the environment. RMAX GeoFoam® offers no nutritional value to most insects and does not attract ants, termites or rodents. It is unaffected by the normal range of climatic conditions and when specified and installed correctly, it can be considered a permanent long-life fill solution.

RMAX GeoFoam® has a long service life and is able to withstand the effects of long term temperature cycling and will retain its physical properties under engineered conditions of use. There are civil road projects in the United States that used geofoam as far back as the 1970's which are still in full service today. Geofoam has also been in use in similar applications in Australia since its introduction in the early 1990's by RMAX. For applications in areas where termites are known to be a problem, RMAX GeoFoam® can also be manufactured with a termite repellent additive.

RMAX GeoFoam® insulation characteristics

EPS is one of the most efficient man made thermally insulating materials currently available. EPS insulation has been used in residential and commercial building construction in ceilings walls and floor systems etc, for many years. The insulative capacity of RMAX GeoFoam®, in most civil applications, is not usually one of the principal reasons for its selection, however in applications such as green roofs and in specific road construction applications where permafrost can be an issue, its insulative capacity becomes a very important consideration for material selection.

RMAX GeoFoam® protection from exposure to fire

RMAX GeoFoam® is manufactured with a flame retardant which inhibits the early stages of fire development, however like many construction materials, EPS is combustible. Where RMAX GeoFoam® is to be applied, appropriate precautions should be implemented on site. The RMAX GeoFoam® should be suitably protected from exposure to open flame from processes such as welding or other hot work. When installed, the RMAX GeoFoam® is protected from exposure to open flame or fire by the soil, concrete or other forms of cover material.

RMAX GeoFoam® UV light exposure

EPS is susceptible to ultra violet (UV) degradation if exposed to direct sunlight for long periods of time. UV degradation caused by prolonged exposure to sunlight can be identified by the development of a pale yellow coloured friable layer which develops directly on the surface of the RMAX GeoFoam® blocks over time. This friable layer is normally only a few mm deep and can be safely and effectively removed by a scourer or the use of a high pressure water cleaner. The development of this friable layer will have a negligible detrimental effect on the physical properties of the RMAX GeoFoam®.

It is recommended that in areas of high UV concentration or where the blocks may be exposed to sunlight for extended periods of time (weeks or months), that where ever possible, the blocks be kept under shaded cover or physically covered using a hessian canvas or other UV resistant type material. **Under no circumstances however should a clear plastic cover be used to cover the blocks if they are intended to be on site for prolonged periods of time prior to installation.**

RMAX GeoFoam® Physical Properties

RMAX GeoFoam® wind exposure

Due to the light weight nature of RMAX **GeoFoam**®, exposure to high winds should be avoided. Where applicable, wind speeds should be monitored on site during project construction. Where possible, installation and movement of blocks should be avoided on windy days. Furthermore, where strong winds may prevail and are an ongoing concern on a given job site, overburden weight restraints such as sandbags should be placed on top of each of the EPS geofoam blocks once the blocks have been installed in place (as per the photo below). All installed blocks should be tethered together by way of geofoam geo-grippers to prevent the potential for the individual blocks shifting under the influence of strong wind loads.

RMAX GeoFoam® buoyancy

Because of its closed-cell structure and light weight characteristics, RMAX **GeoFoam**® is very buoyant. As a function of this, care must be taken during civil project design, construction and post-construction to ensure that any potential for exposure of the RMAX **GeoFoam**® blocks to hydrostatic uplift forces has been accounted for within the hydrological conditions of the site in question. Adequate surcharge, i.e., soil or pavement cover, or an alternate means of passive restraint (anchoring of the blocks) must be provided to guard against the potential for hydrostatic uplift of the blocks once installed.

Alternately, the material can be installed above the water table or the water table can be lowered using suitable drainage techniques and/or other dewatering systems. Drainage (generally a sand or gravel layer) can be provided between the RMAX **GeoFoam**® fill and the natural soils to reduce the potential for hydrostatic uplift. Providing for adequate drainage of groundwater and/or surficial waters below the RMAX **GeoFoam**® prevents water from infiltrating upwards through to the geofoam layer and reduces the potential for development of hydrostatic uplift forces which could cause displacement of the RMAX **GeoFoam**® blocks.



RMAX GeoFoam® Physical Properties

RMAX GeoFoam® water absorption characteristics

RMAX GeoFoam® is non-soluble and has a closed-cell structure that limits water absorption and inhibits the mass migration of liquids through its structure. Even under prolonged saturation the EPS bead cells maintain their physical shape, size, cohesion, appearance and structural integrity.

When used in well-drained conditions, no change in RMAX GeoFoam® block weight is expected to occur as a function of exposure to water or moisture over time. However a negligible increase of less than 5% in the overall weight of RMAX GeoFoam® blocks can be expected over time if the blocks are installed in a partially or completely submerged application. Relative water absorption rates even when submerged, are reduced with increasing RMAX GeoFoam® density.

Although the generic water absorbency of RMAX GeoFoam® is low as per the information above and in the physical properties table on page 24, where RMAX GeoFoam® is to be considered for installation in a partially or fully submerged application, the selection of a higher density RMAX GeoFoam® or Geofoam manufactured from the proprietary RMAX Peripor EPS material is recommended.

RMAX GeoFoam® product sustainability

On site RMAX GeoFoam® block off cuts can be reused in other areas of the site or can be recycled into a variety of differing products and applications such as picture frames, and lightweight concrete.

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. Using lightweight RMAX GeoFoam® significantly reduces these loads.



RMAX GeoFoam® 50 year Limited Product Warranty

RMAX, a division of Huntsman Chemical Company Australia Pty. Ltd. is the manufacturer of the RMAX GeoFoam® Product. This warranty shall apply to the RMAX GeoFoam® product and shall be read and construed in conjunction with RMAX's standard terms and conditions of sale. In the event of any inconsistency, the provisions in this warranty shall prevail.

RMAX GeoFoam® Warranty:

RMAX warrants that for a period of 50 years, commencing with the date of delivery (the "Warranty Period"), that the RMAX GeoFoam® product will maintain 90% of its ASTM D6817 Compressive Resistance as tested at 1 % strain using the D1621 test method. If during the Warranty Period, the RMAX GeoFoam® is determined by sampling and testing in the manner described below not to meet warranty value, RMAX will, subject to the clauses set out below, either deliver to the owner of the project on which the RMAX GeoFoam® was initially installed ("Owner"), a quantity of equivalent RMAX GeoFoam® product to replace the non-performing RMAX GeoFoam® or, at RMAX's sole discretion, refund to the Owner, the original purchase price of the non-performing RMAX GeoFoam®.

RMAX GeoFoam® Sampling and Testing:

All sampling shall be conducted in accordance with sampling procedures prescribed by RMAX. Samples of the RMAX GeoFoam® shall only be taken in the presence of an authorised RMAX representative. Testing of RMAX GeoFoam® samples shall be undertaken in accordance with the requirements of the ASTM D6817 test standard. RMAX GeoFoam® samples shall be conditioned to equilibrium prior to testing. All sampling and testing costs (including but not limited to costs of RMAX GeoFoam® covering removal and replacement) shall be at the Owner's sole expense. Owner agrees to be bound by and shall not dispute the findings and conclusions of the sampling and testing.

RMAX GeoFoam® Warranty Conditions:

RMAX's obligations under this warranty will only take effect if the RMAX GeoFoam® was correctly installed by a skilled and experienced installer in accordance with the product installation recommendations and guidelines issued by RMAX. This warranty shall be void if, in RMAX's sole judgment, the RMAX GeoFoam® performance has been impaired by either damage, abuse or alterations to the RMAX GeoFoam® where such alterations were made without the prior written approval of RMAX.

RMAX GeoFoam® Warranty Exclusions:

RMAX does not warrant the compatibility of any other product (including but not limited to any geotextiles or geomembranes or coatings) with the RMAX GeoFoam®. It is the Owner's sole responsibility to consult with a fully qualified geomembrane or geotextile engineer as to product compatibility with the RMAX GeoFoam® product and the correct installation thereof.

To the full extent permitted by law, RMAX shall have no liability whatsoever in contract, tort, law or otherwise for any loss or damage arising directly or indirectly out of or in relation to the use of any incompatible product (including but not limited to any geotextiles or geomembranes or coatings) with RMAX GeoFoam®.

1. To make a warranty claim, the Owner must provide the following information:

- (a) The details of the RMAX GeoFoam® product purchased. (Application dates, product batch numbers and quantities must be recorded and supplied as a minimum to commence a warranty investigation.)
- (b) The date and location of the RMAX GeoFoam® product purchase.
- (c) A description of the fault observed with the product, providing photographs and samples where possible.
- (d) The contact details of the Owner.

2. The required information can be submitted to RMAX directly by the following means:

- (i) By mail: RMAX Sales, 2-4 Mephan St, Maribyrnong, VIC 2032;
- (ii) By email: sales@rmax.com.au
- (iii) By fax: 03 9317 7888

3. Unless otherwise agreed to in writing by RMAX, the Owner shall bear the full expense of claiming the warranty.

4. Where the Owner is a consumer under the Competition and Consumer Act 2010, the benefits given under this warranty are in addition to the statutory rights and remedies available to the consumer under Australian Consumer Law. Our goods come with guarantees that cannot be excluded under Australian Consumer Law. You are entitled to a replacement or refund for a major failure and for compensation for any other reasonably foreseeable loss or damage. You are also entitled to have the goods repaired or replaced if the goods fail to be of acceptable quality and the failure does not amount to a major failure.

5. There are no warranties and/or guarantees which extend beyond the terms and provisions as set forth in this warranty document. The warranty shall not be extended or altered except by written instrument as signed by an authorised RMAX representative.

6. To the full extent permitted by law, the liability of RMAX for any defect or a breach of the Owner's statutory rights are limited solely to any one or more of the following as determined by RMAX in its sole discretion, namely:

- (i) The supply of replacement product.
- (ii) A refund of the purchase price of the product.

7. Except as expressly provided in this warranty, to the full extent permitted by law, RMAX shall not be liable to the Owner in contract, tort, law or otherwise howsoever and whatever the cause thereof, for (i) any loss of profit, hire, business contracts, revenues or anticipated savings, financial or economic loss, loss of opportunity or (ii) damage to the Owner's reputation or goodwill, or (iii) any loss resulting from any claim made by any third party, or (iv) any special, indirect or consequential loss or damage of any nature whatsoever, and none of these shall be included in any direct damages claim.

RMAX Sales & Service

You can have full confidence in the long term sales and service of RMAX **GeoFoam®** because it is Australian made by RMAX – Australia's largest producer of Expanded Polystyrene products.

With offices and manufacturing plants across Australia, quick and easy delivery of RMAX **GeoFoam®** is assured and with over 50 years of experience, we can advise and answer your most difficult questions. Simply contact your state office and ask to speak to a RMAX **GeoFoam®** consultant today.

References

- AS 1366.3-1992 Rigid cellular plastics sheets for thermal insulation - Rigid cellular polystyrene - Moulded (RC/PS - M)
- ASTM International
100 Barr Harbor Drive, West Conshohocken, PA. USA
- ASTM D5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic friction by the direct Shear method.
- ASTM D6817 Standard Specification for Rigid Cellular Polystyrene Geofoam.
- ASTM D7180-05 Standard Guide for Use of Expanded Polystyrene (EPS) Geofoam in Geotechnical Projects.
- Expanded Polystyrene EPS Geofoam Applications and Technical data.
The EPS Industry Alliance, 1298 Cronson Boulevard, Crofton MD. USA.
- Foam Control Geofoam Tech Bulletin Nos 5008 and 5009.
AFM Corporation Lakeville, Minnesota, USA
- Geopave Technical Note 25 Embankment/Landslip Repair using Expanded Polystyrene.
VicRoads, 2006
- National Cooperative Highway Research Program (NCHRP) Report 529
Guideline and Recommended Standard for Geofoam Applications in Highway Embankments 2004.

Websites

www.fhwa.dot.gov/crt/lifecycle/geofoam.cfm

Website of the USA Federal Highway Administration's Research and Technology Program.

www.geofoam.syr.edu

Website of The Geofoam Research Centre (GRC) at Syracuse University USA

Special Thanks

RMAX would like to thank AFM Corporation for their assistance in providing technical information and input to the production of the RMAX **GeoFoam®** technical product brochure.





RMAX and the Environment

EPS (Expanded Polystyrene) is highly energy efficient in insulation applications. In civil engineering applications RMAX GeoFoam® is efficient and effective providing clean, fast solutions to geotechnical problems. RMAX EPS products do not contain ozone depleting substances and none are used in their manufacture. RMAX promotes the use of EPS for the construction of buildings and in civil construction applications.

Recycling EPS

EPS products are recyclable and RMAX has established recycling facilities in all of its plants throughout Australia. RMAX is a proud member of PACIA (Plastics and Chemical Industries Association).

Energy Efficient Manufacture

The manufacture of EPS is a low pollution process. Steam is the key ingredient and the water is used many times. There is no waste in production as all cut offs or rejects are re-used/ recycled.

RMAX - Innovation Working for You

RMAX is a company driven by innovation. We have pioneered Rigid Cellular Plastics product technologies, leading the development of innovative product solutions for our customers and international partners. RMAX introduced Australia to RMAX GeoFoam® for civil construction in 1992 and has been instrumental in the promotion and development of RMAX GeoFoam® since that time.

Other innovative products from RMAX are ThermaSlab and ThermaProof. For details on these and other products in our range visit www.rmax.com.au

We are committed to working with our customers to deliver high quality creative solutions to construction problems. Contact us and see how our innovative approach using EPS in building construction can help you.

Expanded polystyrene does not contain any ozone depleting substances and none are used in its manufacture.

RMAX pursues a policy of continuous improvement in the design and performance of its products. The right is therefore reserved to vary specifications without notice.

The pictures and illustrations shown in this brochure are for illustrative purposes only to demonstrate creativity and design and construction flexibility. They do not imply that RMAX GeoFoam® was used in their construction.



www.rmax.com.au

+61 411 073 910

geofoam@rmax.com.au

AUSTRALIA

VICTORIA

2-4 Mephan Street

Maribyrnong VIC 3032

Telephone: +61 411 073 910

Facsimile: +61 3 9318 2077

WESTERN AUSTRALIA

5 Baldwin Street

Kewdale, WA 6105

Telephone: +61 411 073 910

Facsimile: +61 8 9353 2002

NEW SOUTH WALES

27 Chifley Street

Smithfield NSW 2164

Telephone: +61 411 073 910

Facsimile: +61 9 9604 7747



NEW ZEALAND

Barnes

368 Church Street

Penrose Auckland 1061

Telephone: +64 9 579 9725

Facsimile: +64 9 579 0472



RMAX is a division of Huntsman Chemical Company Australia Pty. Limited
ABN 48 004 146 338