POLYROCK®

Geotechnical lightweight construction
E.P.S for civil and roading construction
Introduction
Geotechnical engineers and contractors in New Zealand are all too familiar with the problems of road construction in poor load-bearing areas. Traditional construction methods using conventional fill materials can be both impractical and uneconomic.

POLYROCK® from Bondor New Zealand Limited is the perfect choice of material for this type of situation. Consisting of moulded Expanded Polystyrene (EPS), not only does POLYROCK® offer a unique combination of very low density, significant load-bearing capacity and long-term stability, but it is also extremely fast and simple to install.

These features make POLYROCK® suitable for numerous other geotechnical applications where a dramatic reduction in vertical and/or lateral loads is required.

From initial trials of the product in Europe in the early 1960’s, the use of EPS in geotechnical applications is going through a period of sustained growth worldwide.

Bondor New Zealand Limited has the answers for all lightweight fill situations. Not only do we have state-of-the-art plant and national production facilities, but we provide comprehensive technical support from our nationwide branch network, as well as numerous international sources.

Overview & Applications
POLYROCK® consists of expanded polystyrene beads moulded into solid blocks.

Weighing in at approx. 1/100th the weight of conventional fill, POLYROCK® blocks virtually eliminate the lateral and vertical movement and complete bearing failure often associated with construction on poor load-bearing soil. There is also minimal settlement or long term compression of soil layers. This can lead to substantially reduced costs for structures, foundations or ground improvements and on-going maintenance costs.

POLYROCK® also provides solutions to reduce loads on underground services, reduce lateral pressure and differential settlement at bridge abutments and aid in the reconstruction of embankments.

Embankment Profile
A lightweight fill material that creates considerable programme efficiencies and is both cost competitive and easy to install Fig.1-3

EMBANKMENT PROFILES

Fig.1 CONVENTIONAL EMBANKMENT STRUCTURE

Fig.2 POLYROCK® EMBANKMENT STRUCTURE

Fig.3 RETAINING COMMERCIAL AND RESIDENTIAL

POLYROCK® almost eliminates lateral loading on retaining structures
Applications at a Glance

The information herein is the result of over 30 years of international testing and monitoring. Bondor New Zealand Limited’s technical staff are pleased to provide additional international data on request and can discuss POLYROCK® applications for specific projects nationwide Fig.4-7

Common Applications:

- **Lightweight**
- **Strong**
- **Thermal**

**Geotechnical Fill**
Geotechnical fill over poor load-bearing subsoil for roading or embankments.

**Backfill**
Backfill behind earth retaining structures.

**Structural Fill**
Structural fill beneath buildings.

**Hillside Roading**

**Embankments**
Widening existing embankments.

**Repairing subsidence**
Repairing damage caused by subsidence and settlement.

**Bridging Sensitive Underground Structures**

**Replacement of Poor Soils**

**Reduction of Differential Settlement**

**Problem Sites**
Sites with difficult or restricted access.

**Protection From Frost Heave**

Fig.4 **ROAD EMBANKMENTS**
Reduce loads on subsoil compared to conventional embankments. This is the most common application for POLYROCK® so far.

Fig.5 **ABUTMENT BACKFILL**
To reduce lateral pressure and differential settlement at bridge abutments.

Fig.6 **LIGHTWEIGHT FILL**
For the protection of existing underground services such as stormwater or sewage pipe systems.

Fig.7 **HILLSIDE ROADING**
Construction of hillside roading embankments in steep terrain.
**POLYROCK® Properties**

POLYROCK® has the following performance characteristics:

**Compression**

POLYROCK® is a thermoplastic material that under compressive load acts in a viscoelastic manner. This means that above certain levels of compressive load, POLYROCK® won’t recover all of its original thickness when the load is removed. Typically, POLYROCK®’s compressive stress at 10% compressive strain is the quoted performance characteristic, even though this is well into the region of permanent deformation. **Fig.8** To select the correct POLYROCK® density, the elastic region of the compressive strain versus stress curve is of interest.

The designer must ensure that the short-term design load combination (e.g. dynamic traffic loadings) is less than 1% of the initial compressive strain indicated for the chosen density in **Fig.9**

The long-term design load combination (that results from permanent loading) must be less than a total compressive strain of 1.5%, as shown in **Fig.10**

**Density**

POLYROCK®’s most important characteristic is its very low density. Typical densities range from 15kg/m³ to 28kg/m³ although this can be customised for specific applications. Selecting the correct POLYROCK® density is primarily based on the compressive loads that will be applied during its service life.

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**Fig.8**

**Fig.9**
Water Absorption

Despite its low density, POLYROCK® will absorb only a limited amount of water. Immersion for a year results in approximately 5% by volume water absorption. Water may also be drawn into POLYROCK® by capillary action, but only in very limited quantities. Such levels have no significant effect on POLYROCK®’s mechanical properties or performance. Where POLYROCK® is likely to be permanently immersed, a design density of 100kg/m³ should be used by the designer. Conversely, to ensure buoyancy, a design density of no more than 20kg/m³ should be used.

Dimensional Stability

POLYROCK® is supplied non kiln-dried. However, block dimensions will still not vary by more than 1% from block to block.
Fire Resistance
POLYROCK® contains a fire retardant that restricts the early stages of fire development. If ignited, POLYROCK® will self extinguish if the ignition source is removed. If the fire takes hold above temperatures of 350-400°C the flame retardant in POLYROCK® will not prevent further combustion. Under standard test conditions, burning POLYROCK® produces much lower concentrations of asphyxiant carbon monoxide than burning timber.

Biological Properties
POLYROCK® won’t damage the environment, impact on the water table or affect the chemistry of ground water. Nor will it offer a breeding ground for micro organisms.

Chemical Resistance
At ambient temperatures, POLYROCK® is chemically resistant to most substances naturally occurring in the ground and a wide range of other substances such as sea water, dilute acids, alkalines and bleaching agents. Substances such as animal fats and diesel fuel will attack the surface of POLYROCK®, and organic solvents, petrol and concentrated acids can affect POLYROCK® to some degree. However, in all these cases the substances must be present in high concentrations to adversely affect POLYROCK®’s performance. Although such high concentrations are uncommon, POLYROCK® can be protected from chemical attack as an additional safeguard.

EPS and the Environment
Extensive international testing shows that POLYROCK® does not degrade into harmful substances, or release any type of contaminant.

EPS plays a positive role as an insulation product in reducing carbon dioxide emissions, and POLYROCK® does not require the use of CFC’s, HCFC’s or any ozone depleting gases in manufacture.

### Chemical Resistance of POLYROCK®

<table>
<thead>
<tr>
<th>Contacting Substance</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saline solutions, seawater</td>
<td>○</td>
</tr>
<tr>
<td>Soap, detergent solutions</td>
<td>○</td>
</tr>
<tr>
<td>Bleaching solutions e.g. hydrochlorite, chlorine water, hydrogen peroxide</td>
<td>○</td>
</tr>
<tr>
<td>Dilute acids</td>
<td>○</td>
</tr>
<tr>
<td>35% Hydrochloric acid 50% nitric acid</td>
<td>○</td>
</tr>
<tr>
<td>Fuming sulfuric acid, glacial acetic acid, 100% formic acid</td>
<td>■</td>
</tr>
<tr>
<td>Caustic soda or potash solution, strong ammonia</td>
<td>○</td>
</tr>
<tr>
<td>Organic solvents e.g. acetone, ethyl acetate, toluene, xylene, thinners, ethylene</td>
<td>■</td>
</tr>
<tr>
<td>Saturated hydrocarbons e.g. white spirits, solvent, petroleum</td>
<td>■</td>
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<tr>
<td>Petroleum jelly, white oil</td>
<td>■</td>
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<tr>
<td>Diesel fuel</td>
<td>■</td>
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<tr>
<td>Gasoline (all grades)</td>
<td>■</td>
</tr>
<tr>
<td>Alcohols e.g. Methanol, ethanol</td>
<td>●</td>
</tr>
<tr>
<td>Silicone oils</td>
<td>○</td>
</tr>
</tbody>
</table>

**Key:**
- ○: No effect, even after prolonged contact
- ●: Surface attack or shrinking after prolonged contact
- ■: Unresistant, will shrink or dissolve.
Protecting POLYROCK®

Appropriate protective measures need to be taken to prevent damage to POLYROCK® from harmful substances such as organic solvents, motor fuels and from the possible effects of fire Fig. 11. The recommended measures are:

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Harmful Substances

Bondor New Zealand Limited recommends the use of impermeable geomembranes to protect POLYROCK® from the effects of petrol and solvents. Such membranes should have performance properties appropriate for the situation and be installed in strict accordance with the manufacturer’s recommendations.

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Fire Protection

The most effective method of protecting POLYROCK® from the effects of fire is to use concrete slabs/walls. Conventional fill will also be effective in some applications. Bondor New Zealand Limited recommends that such methods provide the equivalent of a four-hour fire resistance, which can be achieved by either 150mm concrete thickness or 1.0m of fill material.

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Storage and Handling

POLYROCK® is a lightweight material easily handled on construction sites. Ideally, the material should be placed in its final position as soon as possible after delivery. It should be protected from possible damage and anchored down against wind gusts.

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Placement

A bedding layer of sand to a minimum thickness of 50mm is recommended to give POLYROCK® a firm, stable base. Care must be taken to achieve a smooth level base foundation. This will make placement of subsequent layers much easier. Individual layers generally consist of blocks of uniform thickness and size. The orientation of blocks in subsequent layers should alternate so that joints are always staggered. At longitudinal transitions, different layers of POLYROCK® blocks are progressively stepped so that POLYROCK® and normal fill gradually overlap – this will minimise the effects of differential settlement. At the side of embankments, the blocks of POLYROCK® should be similarly stepped to assist with soil stability. The depth of soil cover on side slopes should never be less than 250mm.

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Programming

POLYROCK® can be installed at a rate exceeding 1000m³ per day, dependant on access and availability of delivery. As each block weighs only 60-120kg, POLYROCK® can be easily handled and moved once on site.

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Plant and Equipment

The operation of plant directly on the surface of your POLYROCK® needs to be restricted to avoid permanent deformation of the product. No plant should operate over POLYROCK® until it is covered with 150mm of fill. Only lightweight compacting equipment should be used until filling is completed. Care should be taken when operating other plant and equipment adjacent to POLYROCK®.

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Miscellaneous

Consideration should be given by the designer to drainage of the layer above POLYROCK®. For example, a sand layer tapering away transversely from the centre line with a protective membrane laid will assist drainage. Provision also needs to be made at the periphery for services and fixtures. The thickness of fill above POLYROCK® will also need to accommodate planting and landscaping.

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California Bearing Ratio (CBR)

Although subgrade CBR values have been determined for POLYROCK® as a fill material. The behaviour of Polyrock can not necessarily be compared to that of a soil subgrade.

In order to give an indication of the CBR values that POLYROCK® can achieve, a limited number of samples have been tested. The results indicate 2% for the lower grades (nominal density 15 kg/m³) and 3% for the higher grades (nominal density 28 kg/m³).

It is important to understand that POLYROCK® is a material that is designed for specific purposes and has unique characteristics which conventional subgrade/fill materials are unable to offer.

When undertaking design for POLYROCK®, it is recommended that the designer understands the actual pressures transmitted to the POLYROCK® and that the appropriate POLYROCK® grades and total construction thicknesses are selected accordingly.
New Zealand POLYROCK® Projects Completed

Botany Downs Town Centre
POLYROCK® was introduced to the New Zealand market when it was used for a large project at the Botany Downs Town Centre – in this case POLYROCK® was used primarily in the protection of existing underground services (storm water pipe). On this project Tonkin & Taylor Ltd were the geotechnical design engineers, with the main contractor being Mainzeal Construction.

Glamorgan Drive, Torbay
In order to access a new subdivision at 276-280 Glamorgan Drive, Torbay, on the North Shore of Auckland, a cul-de-sac right-of-way would need to be constructed over a poor load bearing soil. In fact the underlying soil was so unstable, that additional load would certainly result in failure. To alleviate these additional loads, in excess of 350 cubic metres of POLYROCK® were laid as the foundation for the right-of-way, offering both a suitable light weight in the vertical plane, as well as offering almost no lateral loading to the retaining structure constructed to contain this new roadway. This project was designed by McGuijan Syme Chilcott Ltd consulting engineers and site work was carried out by Boss Construction Ltd of Albany.

ALPURUT SH1 Project
The combined effort of W Stevenson & Son Ltd, Connell Wagner and Bondor New Zealand Limited resulted in a new benchmark for road construction in the future. The ALPURUT (Albany to Puhoi Realignment) SH1 A1 Section near Oteha Valley Road has had its share of difficulties - such as time constraints in filling a 30m high earth embankment. Rapid earth filling could have caused embankment failure. Bondor New Zealand Limited’s POLYROCK® was chosen as the fast and simple solution to increase the safe filling speed and to form the pavement subgrade.

Arthur’s Pass SH73 Rock Shelter
The road widening project between Candy’s Bend and Starvation Point in the Arthur’s Pass region of the Southern Alps was a challenging engineering project. Fulton Hogan Civil were given the task of constructing the rock shelter, using concrete pillars, concrete slabs and Bondor New Zealand Limited POLYROCK®. The POLYROCK® fill is sandwiched between the ‘ceiling’ slab and the ‘roof’ slab of the shelter. Its job is to absorb the impact of rockfalls.

POLYROCK® had all the right qualities for this job: good strength to weight ratio, elasticity, and prefinished nature allowing quick and easy installation.

Harvey Norman Building, Whangarei
2400m³ of Polyrock® used to support the foundation for the concrete slab. Polyrock® was used to avoid problems associated with Onerahi Chaos soil type, and differential settlement. The lightweight nature, cost effectiveness and strength of Polyrock® provided a unique lightweight geotechnical fill solution.

For many applications of POLYROCK® further information is available from Bondor New Zealand Limited.

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