LYTAG®
lightweight solutions

Uniclass L6129	EPIC F122
CI/SfB (-A) Yp3	

Technical Manual – Section 16
Geo fill®

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Introduction

This document details the properties of Geo fill® civil engineering bulk fill and drainage medium material which can be used when assessing it's suitability for use against such specifications as the Specification for Highway works, BS EN 1610 – Construction and testing of drains and sewers, BS EN 13242 – Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction. It can be used, where necessary, to provide information when requests for a variation to the contract documents are to be requested.

Company

Lytag Ltd has been supplying lightweight aggregate for over 40 years and has sold in excess of 16 million tonnes of material. Manufactured within the European Union in accordance with EN 13055, the standard for lightweight aggregates, Geo fill is widely available within the UK and Europe. Supplies to other parts of the globe can easily be arranged.

Product

The raw material used in the manufacture of lightweight aggregate is pulverised fuel ash (fly ash). This is the waste material produced from electricity production in coal-fired power stations. This aggregate is called 'sintered pulverised fuel ash lightweight aggregate', more commonly known as Lytag of which Geo fill is a specially selected grade.

It is made by pelletising the fly ash. By adding a controlled amount of water in specially designed dish pelletising pans, rounded pellets are formed. The pellets are then heated on a sinter strand to a temperature of around 1100^{o}C. The result is a hard, honeycombed structure of interconnecting voids within the aggregate. The particles formed are rounded in shape and range in size from 14mm down to fines; these are processed to the required grading, depending on the final use.

Being a wholly manufactured aggregate, made from a waste stream, means that the quantity of fly ash being tipped is reduced and virgin aggregate extraction is reduced.

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Applications

Due to the rounded nature of the particles and the reduced weight of the material, Geo fill civil engineering bulk fill has a wide number of applications and has been used successfully for many years as backfill and drainage material.

Geo fill should be considered for use as an alternative to 'normal' weight aggregates in series 500 and 600 of the Specification for Highway Works.
The physical and chemical data of the material is given in Table 1 of this document. Where required, other sizes and gradings may be available.

Because of the particle shape and porous nature of the Geo fill material it is free draining, allowing water to pass through rapidly. It also has a relatively high absorption allowing it to soak up excess water quickly, returning it slowly to the surrounding area.

- **Bulk Fill** – Geo fil can be used as a bulk fill material either bonded with cement or unbonded. Densities are typically 700 to 900 kg/m3, depending upon the ambient moisture content, which reduces the dead load and lateral pressure. Due to the spherical shape of the aggregate,
  minimal compaction is required.
- **Drainage media** - The particle size and shape of Geo fill gives it excellent hydraulic conductivity properties. It can be shown that up to six times more water will pass through the aggregate than standard gravel aggregates, reducing the risk of silt blockages in trench systems. Finely graded lightweight aggregate can be used allowing grass to grow and 'knit' over the trench in a few days.
- **Arrestor beds** - Geo fill is used in arrestor beds to bring run-away vehicles to a halt in a controlled manner. Risk of injury and damage to vehicles is minimized. The aggregate does not degrade or compact over time, keeping it effective with the minimum of maintenance.
- **Pipe bedding** - Geo fill is used as a granular bedding and sidefill for rigid and flexible pipes. BS EN 1610 – Construction and testing of drains and sewers details the design requirements

Geo fill will reduce pressures on both foundations and structures due to being approximately 50% of the weight of 'normal' aggregate, whereby savings in the design can be made.
In example 1 it is shown that by just using Geo fill in place of natural gravel can reduce pressures on a retaining wall by around 65%.

Maximising the benefits of Geo fill can lead to savings in the overall design of retaining walls and fills as shown in example 2.

Examples

In both the examples the following assumptions have been made:-

- Gravel loose bulk density – 1700kg/m^3
- Friction angle – 35o
- Geo fill® loose bulk density – 810kg/m^3 Friction angle – 42o
- Wall height – 4m

Example 1 - Using Geo fill® in place of natural gravel

Gravel				
Unit weight	17	kN/m^3		
Friction angle	35	degrees	0.611	Radians
Geo fill®				
Unit weight	8.1	kN/m^3	Assuming 14% moisture	
Friction angle	42	Degrees	0.733	Radians
Example retaining wall 4m retained height				
Assume level backfill				
Active pressure calculations	q2 = k2 x D x h			
q2 = active pressure				
k2 = active pressure coefficient				
h = retained height	4	m		
k2 – gravel	0.27			
k2 - Geo fill®	0.20			
Active pressure - gravel; q2=	18.43	kN/m^2		
Active pressure - Geofill®; q2	6.42	kM/m^2		
Ratio between Geofill® and gravel pressures	0.35			
Geo fill civil engineering bulk fill exerts 35% of the pressure exerted by a gravel fill				

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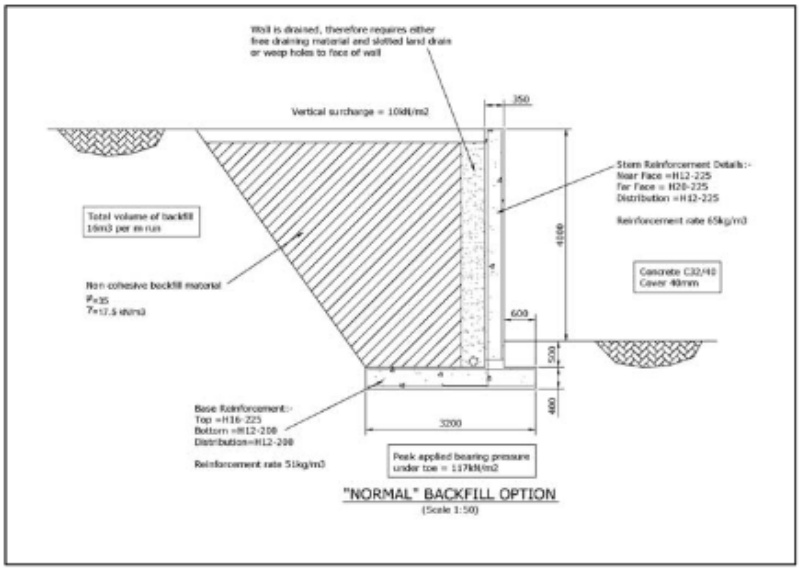
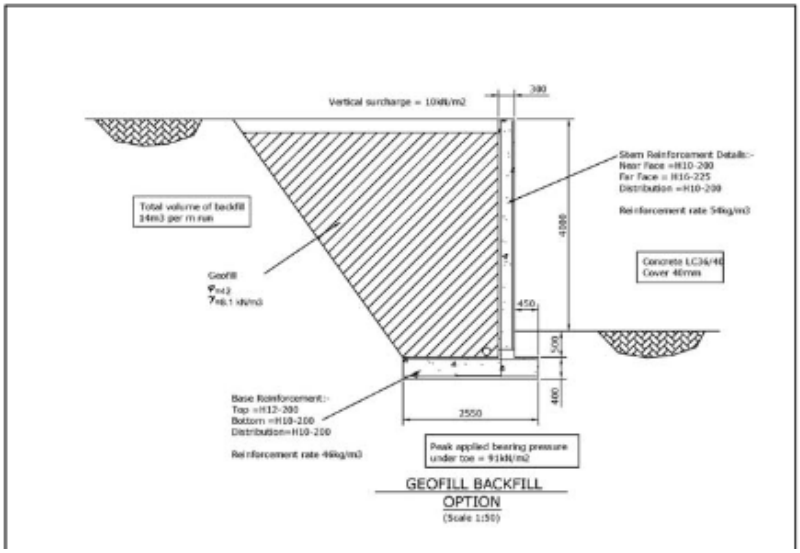
Example 2 - Overall redesign of retaining walls and backfills





Geo fill option compared with generic gravel fill,

- Uses 26% less volume of concrete
- Uses 35% less weight of reinforcing
- As well as using less material a reduction in ground pressure of 22% applies.

The above are generic examples and should not be used in actual design situations.

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Compaction

When placing Geo fill only minimal compaction is required. For smaller areas the material should be placed in layers of 300mm deep and raked and lightly vibrated to settle into position. Heavy compaction methods should not be used as this may crush the aggregate particles.

When covering larger areas or volumes Geo fill may be spread by tracked vehicle. Depths greater than 300mm can be placed, depending on local conditions, however full compaction should be ensured. Care should be taken when adopting this method to avoid surface crushing of the Geo fill.

As well as reducing pressures exerted on new structures both during construction and in the longer term, savings can also be made on manpower, time and plant.

Environmental considerations

As Geo fill is manufactured from a waste stream material, the need to extract virgin materials to obtain the aggregate is negated. The original waste ash from the power station does not need to be sent for landfill, hence reducing the requirement for valuable land space.
As Geo fill is approximately 50% of the weight of 'normal' aggregate, twice the volume can be carried in road vehicles. This significantly reduces vehicle movements on the highway and on and of site.

Where manual handling of the aggregate is required the lighter weight of the aggregate makes it easier to move, hence reducing the physical strain on operatives.

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Geo fill® Civil Engineering Bulk Fill Properties

Property	Geo fill
Dry loose bulk density (BS EN 1097-3)	710kg/m_3
Uniformity Coefficient	
(D60/D10) (Highways specification)	1.4
Typical moisture content as delivered (BS EN 1097-5)	15%
Long term maximum moisture content	30%
Resistance to Fragmentation LA (BS EN 1097-2)	40
Water soluble Sulfate (TRL 477 test 1)	0.4g/l
Oxidisable Sulfate (TRL 477 test 2 & 4)	0.27%
Total potential Sulfate (TRL test 4)	0.69%
Chloride ion content	0.01%
Permeability m/s (BS EN 1377-5)	1.3 x 10-1
pH (BS EN 1377-3)	9.2
Effective angle of internal friction Highways Specification Cl 636	39o
Effective cohesion	
Highways Specification Cl 636	39kPa
Aggregate crushing strength (BS EN 13055)	6.5N/mm_2

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