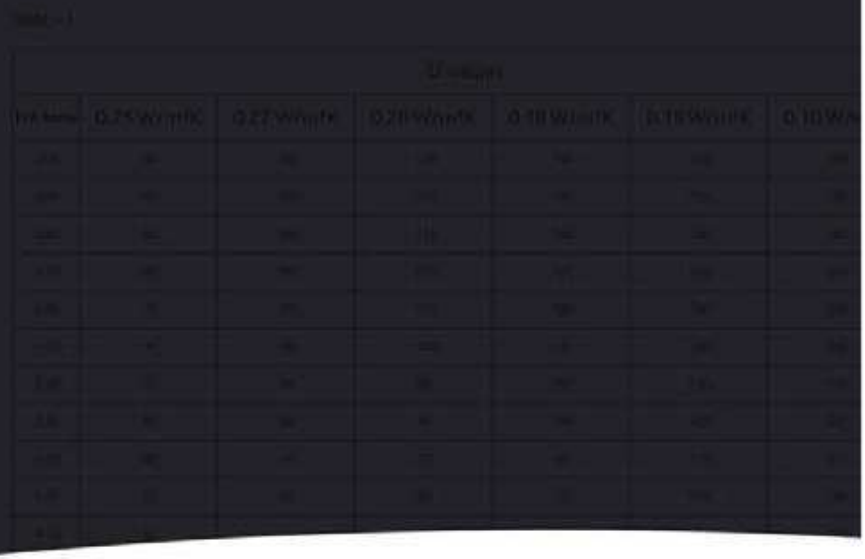
Floors | Walls | Roofs

Jablite Fillmaster in Road Widening



jablite

Design Consideration

Traditional fill materials used to construct new embankments or placed against civil engineering structures, can cause unacceptable vertical and/or horizontal stresses in the underlying soil or against the structure. The use of Fillmaster expanded polystyrene as a fill material offers a reliable, cost-effective lightweight solution to these problems, reducing the probability of further settlement or unacceptable lateral forces and often simplifying the construction.

Vencel Resil manufactures Fillmaster expanded polystyrene (EPS) blocks for use in civil engineering projects, especially road construction. The material is available in a range of sizes and strength grades. The cellular structure of the EPS material gives a high strength-to-weight ratio ensuring that the blocks are able to withstand the mechanical loads encountered in road construction.

Advantages

- Lightweight and easy to handle on site. Approximately 1% of the weight of traditional fill materials.
- Available in a range of grades allowing the appropriate compressive strength to be chosen to suit each particular application.
- Closed-cell structure inhibits water absorption.
- Unaffected by normal range of climatic conditions.
- Immune to insect, bacterial and fungal attack.

Description

Grade

Fillmaster is supplied in the grades shown in Table 1. Normally supplied as Euroclass F defined to BSEN 14933: 2007, it is also available as Euroclass E, flame-retardant additive material, if required.

Dimensions

Fillmaster standard block size:
2440 x 1220 x 610mm; other sizes available to order to reduce the need for cutting to size on site. The stability of a lightweight embankment depends greatly on the uniformity of the blocks. Tolerances: ±3mm on thickness; ±4mm on width; and ±6mm on length. Maximum bow, 5mm over length of block.

Application

Expanded polystyrene has been successfully used as a fill material for highway embankments since 1972. Its first such use in the UK was in 1985. The material is particularly beneficial in the following situations where its use will obviate the need for either specialised foundations, or long surcharge periods designed to preload the ground and reduce settlement problems following construction:

- Areas adjacent to existing embankments.
- Areas of unstable ground.
- Areas of weak or compressible soil.
- Sites where access is difficult or restricted.
- Ransition zones between bridges or underpasses and normal fill materials.

Figure 1. HA Loadings

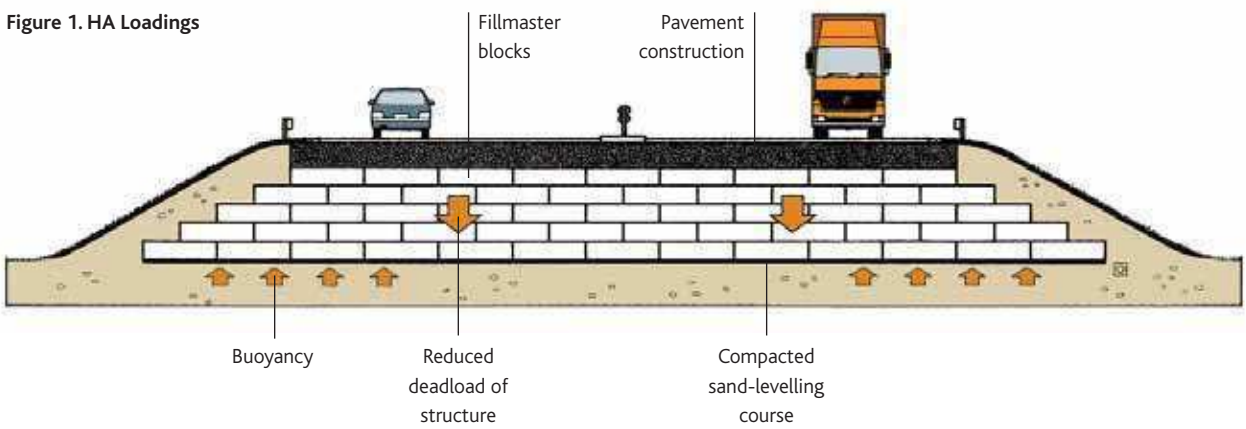


Table 1

Physical Properties – Fillmaster										
Fillmaster Grade	FM50	FM70	FM100	FM150	FM200	FM250	FM300	FM350	FM400	FM500
Compressive Stress at 1% strain (kPa)	10	20	45	70	90	100	120	140	160	190

Design

Embankment forces

There are three main design considerations when constructing embankments using Fillmaster:

- Downward pressure due to wheel loadings and the self-weight of the embankment.
- Upward forces due to buoyancy in wet conditions.
- Lateral forces acting against abutments.

Wheel loadings

In order to avoid unacceptable deflections and permanent deformation of the highway surface, the compressive stresses due to wheel loadings, etc., should be carefully calculated and the appropriate grade of Fillmaster selected to ensure that these fall within the design compressive strength of the material. It is recommended that this is carried out in accordance with the method of calculation for the thickness of sub-base/subgrade set out in BS 5400. This uses the convention of 'HA' and 'HB' units of loading.

HA loading assumes a single 100kN wheel load exerting a pressure of 1110kPa over a square of 300 x 300mm; the pressure is exerted downwards at a gradient of 2:1. This represents the effects of normally permitted vehicles.

HB loading represents the effects of abnormal loads on motorways and trunk roads. It is usual to design for 45 units of HB loading; this represents the effect of 16 wheel loads each of 112.5kN exerting a pressure of 1110kPa over a square of 318 x 318mm. The pressure is dispersed downwards at a gradient of 2:1.

See *Figures 2 and 3*.

Figure 2. HA Loadings

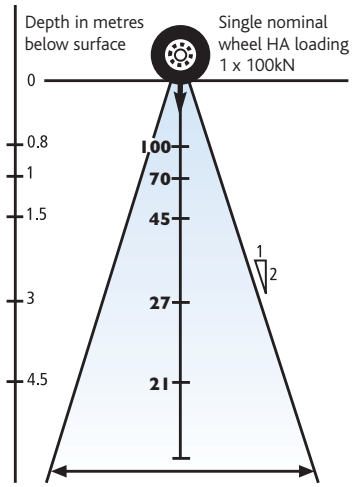
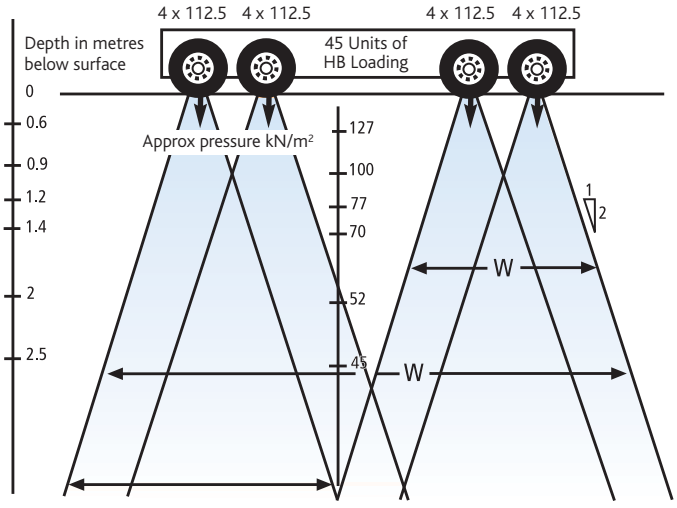


Figure 3. HB Loadings



Design Consideration

Downward pressure

When calculating the self-weight of Fillmaster blocks an allowance should be made for water absorption of less than 1% by volume. This gives a design weight of approximately 100kg/m^3.

Buoyancy pressures

EPS is a proven flotation material and exerts a flotation force of 900kgf/m^3.

This takes into account a potential level of water absorption of 8% for blocks which are permanently submerged.

Care must be taken during the design process to ensure that the potential flotation forces can be accommodated within the hydrological conditions of the site and take account of the self weight of the permanent structure.

Alternatively, the material can be installed above the water table. The water table can be lowered by installing suitable cut-off drains at the toe of the embankment or beneath the embankment itself.

Lateral pressures

When using Fillmaster for approach embankments to bridge abutments, the horizontal forces exerted on the abutment are almost eradicated. This allows economies to be made in the design of bridge foundations, which are no longer required to resist large rotational moments.

Installation

Construction of the embankment should proceed as follows:

Levelling course

Fillmaster blocks are placed on a levelling course consisting of a layer of compacted sand to a maximum thickness of 100mm. This course should be laid to a level tolerance not exceeding ±10mm over any 3m length. On sites which have very soft foundations, a geotextile layer may be placed on top of the soft soil before placing the sand fill, this prevents the sand from being 'punched' into the soil.

Laying the blocks

The blocks in each layer should be laid with broken joints; there should be no vertical or horizontal joints running through the construction.

There is no need to compact the blocks during construction.

The coefficient of friction (μ) between adjacent blocks can be taken as 0.5; this is normally sufficient to prevent any slippage or movement.

When required, for example at the edges of the embankment, a positive fixing can be obtained by driving 12mm diameter reinforcing bars down through the layers.

The final profile of the side slope will depend on the properties of the soil used. Where soil conditions restrict the available space for an embankment, a range of techniques is now available for constructing steep sides or vertical faces.

Cutting

Blocks which require trimming can be easily cut using a hot-wire cutter, handsaw or chain saw.

Protection

The Fillmaster should be protected from possible accidental contact with petroleum or solvents using a suitable polymer barrier, where necessary.

Fill or capping layer

The final fill should be placed over the Fillmaster blocks taking care not to puncture any membrane.

No construction plant, other than compaction equipment, should be driven across, or placed on the Fillmaster until there is a minimum cover of 200mm of acceptable fill material, or until the capping layer has been placed.

Vibratory compaction plant should not be used within 500mm vertically, or 2m laterally, of the Fillmaster blocks.

Cover

The sides of the Fillmaster blocks should be covered with general fill and compacted in layers. The sides should be graded and covered with top soil. The minimum cover should be 300mm.

References

BS 5400 Steel, concrete and composite bridges. Part 2 Specification for loads. Department of Transport Standard BD 37/88. Loads for highway bridges.

Geotechnical considerations and techniques for widening highway earthworks. Department of Transport.

Plastic foam in road embankments. Proceedings of the conference of the Norwegian Plastics Federation. June 1985.

TRL Contractor report 356. The use of polystyrene for embankment construction.

Design Consideration

For technical information 0870 444 8769 technical@vencel.co.uk

Road Widening

The weight of traditional fill materials used to widen embankments can cause unacceptable stresses in the embankment. Fillmaster offers a cost-effective lightweight solution and reduces the probability of further settlement.

Figure 6. Road Widening

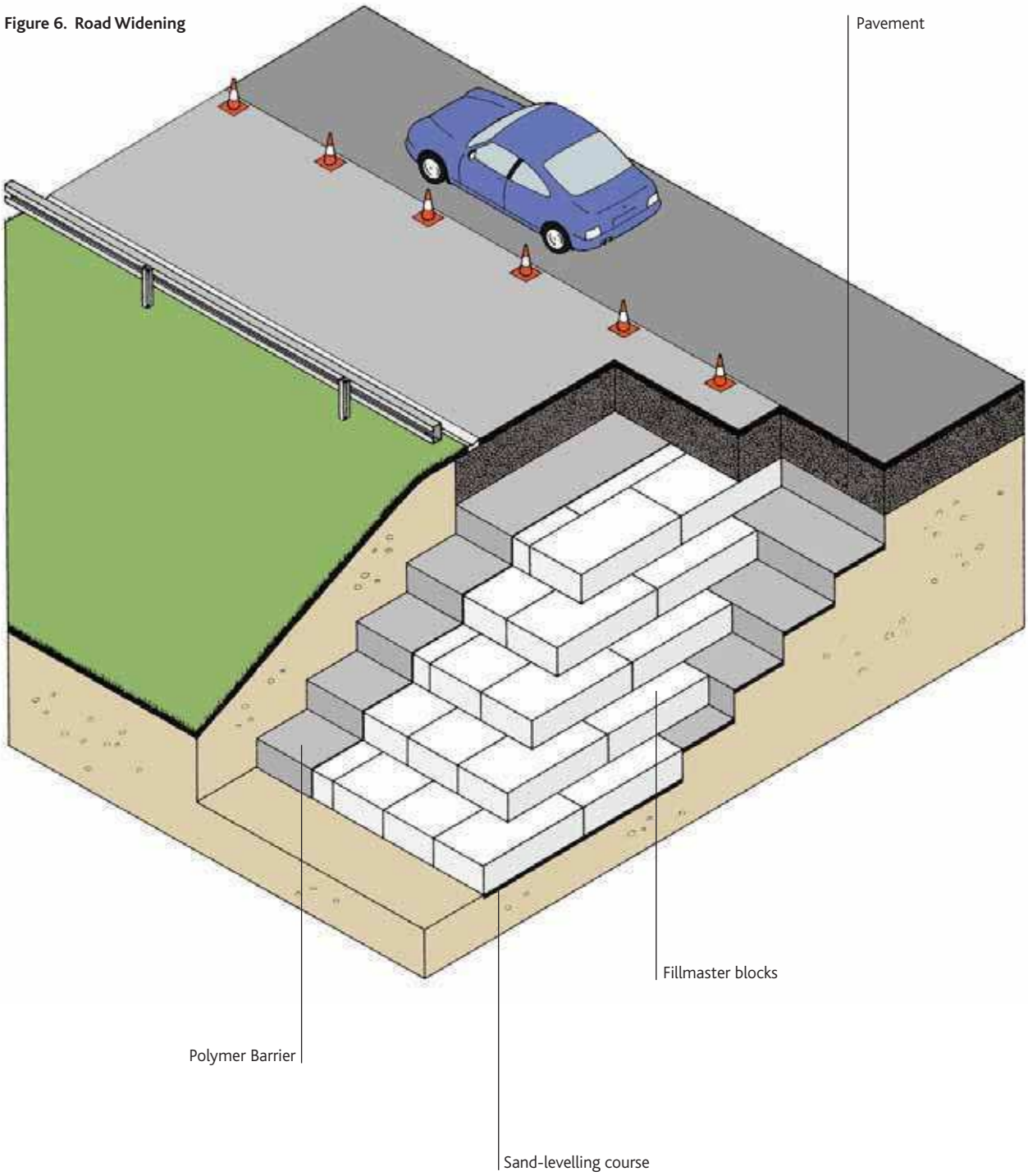
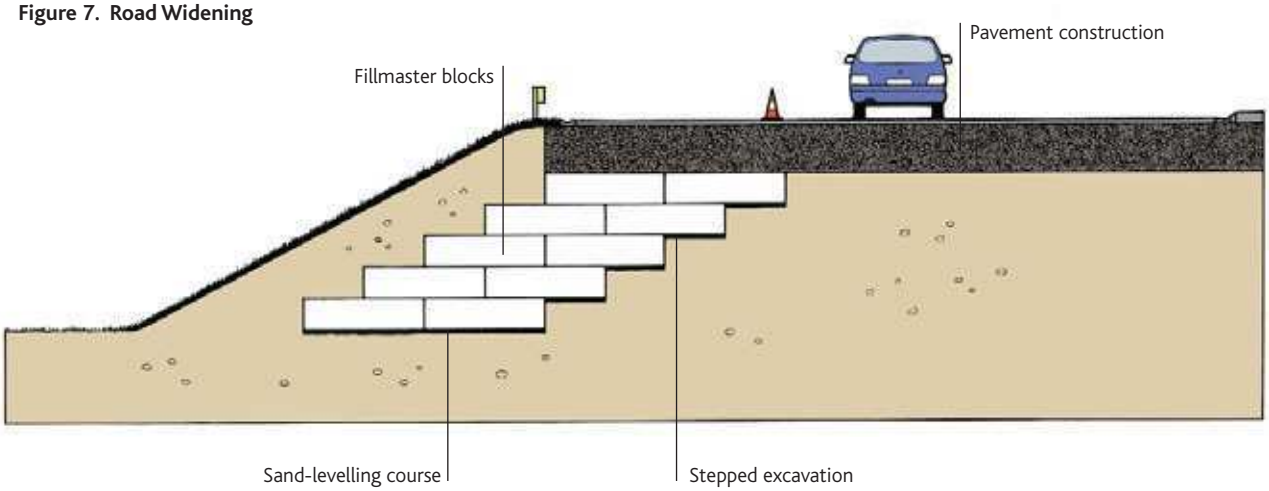


Figure 7. Road Widening



Priory Park Development, Kingston Upon Hull

The first stage of the 60ha commercial and leisure complex was to widen the embankment of Humberside County Council's Priory Way spur road.

The original embankment, built out of PFA ten years previously, had experienced consolidation coupled with settlement due to the weak underlying soils which comprised of soft alluvium over river gravel and Welton chalk. The problem was exacerbated by lateral movement at the bottom of the embankment's edges where material had rotationally slipped outward. If the embankment were to be widened with PFA or ordinary granular fill, the level of further settlement was predicted to be as much as 500mm, compared to 50mm with Fillmaster blocks and topsoil. The engineers also considered that EPS would provide a better overall profile of total settlement compared to PFA.

With the decision to use Fillmaster, 300mm of topsoil was removed and a stepped excavation was carried out with a bench height of 610mm by 1220mm wide. Blocks were benched in position following the use of a sub-base of Type Two granular material and a 50mm sand blinding to act as a drainage layer. Four different grades were required and were clearly colour-coded to avoid any confusion. The highest at 30kg/m^3 was employed in areas required to take the greatest weight immediately beneath the road pavement. The blocks were pinned and covered with a polyethylene membrane as protection against fuel spillage. A thin sand layer, followed by a selected fill, completed the embankment.

Where the embankment was tightly curved, blocks were customised to fit by cutting and shaping with a hot wire. Little plant was required and only six people were employed in the gang.

Work on the Priory Way spur road

Client: Henry Boot Developments
Consulting Engineers: Hannah Reed and Associates, Doncaster
Contractor: Birse Construction, Barton-on-Humber
Volume: 6,300m^3

Technical Data

Table 5. Physical Properties – Fillmaster

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Biological properties

EPS is not susceptible to attack by fungus or bacteria and is non-biodegradable. It offers no nourishment to vegetation or animal life.

Chemical resistance

EPS is resistant to most substances which occur naturally in soil, as well as to a wide range of common substances at ambient temperatures, including:

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

If there is any possibility that the soil with which it is likely to come into contact is contaminated, for example when constructing embankments on reclaimed industrial land, laboratory tests should be conducted to determine the exact nature of the contaminants. Some materials, including vegetable oils, paraffin, animal fats and oils may attack the surface of the EPS causing shrinkage and deformation. However, they are not able to dissolve the EPS nor to penetrate the mass of the material and do not affect long-term stability.

EPS should not allowed to come into contact with hydrocarbons, chlorinated hydrocarbons, organic solvents such as ketones, ethers and esters; diesel and petroleum fuels; and concentrated acids.

If there is any possibility of contact with these substances, either during or after construction, the material should be protected by using an impermeable polymer membrane as a physical barrier. Further information is available from Vencel Resil's technical services department.

Durability

When correctly specified and installed as a lightweight embankment fill, Fillmaster can be considered as a permanent material. Fillmaster also has the added advantage of being floor-proof.

Mechanical properties

EPS behaves as a linear elastic material up to strains of 1% where the elastic limit is exceeded. A typical stress strain curve is shown in Graph 3. Fillmaster creep deformation can be disregarded in embankment applications.

The coefficient of friction (μ) between blocks is around 0.5 along the moulded faces; the figure is higher on cut faces since the surface roughness is increased.

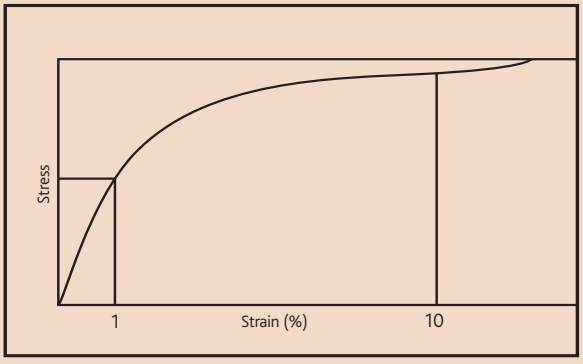
Poissons ratio 0.02.

Moisture properties

EPS is not soluble in water and will not usually exceed a moisture absorption level of 8-10% after long-term immersion.

The closed-cell structure prevents the migration of liquids through the mass of the material.

Graph 2. Typical stress strain curve



Fire

Fillmaster is normally supplied as Euroclass F material as defined in BS EN 14933: 2007; Euroclass E, flame-retardant additive material is also available. EPS will ignite on contact with an open flame and will burn readily in the presence of air. Care should be taken during construction to ensure that the material is not exposed to possible sources of ignition. The use of the flame-retardant additive material will inhibit the early stages of the development of a fire.

Small quantities of residual blowing agent may be present and advice should be sought from Vencel Resil's technical services department when incorporating the product in areas of low natural ventilation.

Fire is not normally a hazard once the material has been placed and covered.

Combustion

EPS is 'combustible' as defined in BS 476:Part 4. When burning, EPS behaves like other hydrocarbons such as wood and paper. For Euroclass F material, the products of uncontrolled combustion are carbon monoxide, carbon dioxide, styrene, and water vapour; the decomposing styrene will emit a certain amount of dense black soot. Euroclass E material also emits hydrogen bromide when burning.

Ignition temperature

Flash ignition temperature is between 350 and 490°C depending on the application and the exact circumstances of use. Under certain circumstances the material can be readily ignited by a naked flame, but providing it is correctly installed this does not present any disadvantage in use.

Calorific value: 40MJ/kg.

Specific heat capacity: 1.13kJ/kg°C.

Environmental issues

EPS does not contain or produce HCFCs, nor are these compounds used in its manufacture. In use, it is non-toxic, non-irritant and odourless.

Due to the high volume and low weight of a lorry load of Fillmaster there are environmental advantages over traditional materials in reducing the number of lorry runs required to supply a contract. This can be particularly advantageous in built-up environments. ($90m^3$ of EPS compared to typically $10m^3$ of traditional fill per lorry load).

The low density of Fillmaster, which is typically 95-98% air, directly reduces the volumes of quarried materials required.

Health & Safety

EPS scores particularly highly when it comes to health and safety. It has many positive attributes, not the least of which is its proven safety record from production through useful life to recycling. EPS is non-toxic and biologically inert. The material is not irritating to the skin or eyes; no medical treatment or action is required as a result of accidental ingestion.

No special precautions are required during handling or cutting where carried out in a well ventilated area. Dust produced by cutting is very light and may cling to the skin or clothing through static electricity; it may be simply brushed away.

The volume of air in EPS boards is 98%, consequently the components in a given volume are correspondingly low, typically 15 to 50 kg/m^3. In polystyrene, styrene monomer, shown to be safe in use, constitutes up to 0.1% by weight of the product. This minute trace of styrene monomer constitutes no threat to health.

The expanding agent pentane, is a saturated hydrocarbon (not to be confused with (HCFCs) and is non-toxic and constitutes no threat to the ozone layer. Euroclass E, flame-retardant additive material, contains around 0.5% of the flame retardant hexabromocyclododecane (HBCDD) which is entrapped in the polymer matrix of the EPS. The HBCDD additive should not be confused with aromatic flame retardants (such as PBBs and PBBOs).

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