



# General Purpose Grout

## Technical Information

**Envirocem General Purpose Grouts are lightweight, economical and sustainable, offering important benefits, such as reduced water to solids ratio and increasing compressive strength over time.**

Envirocem General Purpose Grouts are blends of fly ash and Portland Cement. The fly ash is specially selected from coal burning power stations, while the Portland Cement is supplied from Tarmac Cement's Tunstead Works.

Fly ash, also known as Pulverised Fuel Ash or FA, is the 'fine' ash fraction produced in the furnaces of coal-fired power stations when pulverised coal is fed into the boilers and burnt at high temperatures and pressures. As combustion takes place, the ash within the coal melts and solidifies in flight as rounded glassy particles. These are carried out in the flue gasses and subsequently captured in the electrostatic precipitators.

The FA particles are mostly extremely fine, glassy spheres and can resemble cement in texture. Moreover, they demonstrate pozzolanic properties in concrete - i.e. the FA has the ability to react with lime released by hydrating Portland Cement to produce cementitious hydrates.

Envirocem General Purpose Grouts are available in various FA - Portland Cement blends ranging from 1:1 FA:PC (EGP 1) to a 20:1 FA:PC (EGP 20). Accuracy of the blends are within +/-2% of target.

### Quality Assurance

Envirocem products are manufactured under a total Quality Management System (QMS) that complies with the requirements of BS EN ISO 9001. The QMS is registered and audited by BSI.

### Specification

Envirocem Grouts are manufactured to comply with specifications such as the civil engineering specification for the water industry.

The fly ash used in the grouts complies with BS EN450 (Latest edition) 'Fly Ash for Concrete' and the Portland Cement is manufactured to BS EN 197 - 1. When grouts are used in situations where there may be some risk of sulfate attack, it would normally be satisfactory to use mixtures of FA and Portland Cement.

Note: BS EN 12715:2020 'Execution of special geotechnical work. Grouting' should be consulted.

### Applications

Envirocem General Purpose Grouts can be used for void filling of abandoned sewers, structural grouting behind tunnel segments, curtains around dams and around foundations, strengthening embankments, railway tracks and bridge abutments.

The underpinning of the Royal Scottish Academy in Edinburgh, following subsidence, was carried out using Envirocem grouts, as was work at Castlecary Arches on the A80 to correct ground defects caused by old lime workings.

Groundworks for the National Indoor Sports Arena and Chris Hoy Velodrome for the Glasgow 2014 Commonwealth Games also used Envirocem General Purpose grouts. (EGP) grouts can also be used to repair brick and masonry structures such as bridge piers, church towers, railway tunnels and viaducts.

# Envirocem

## Envirocem Grouts – Portland Cement Grouts

By varying the FA:PC ratio, grouts can be manufactured that offer a wide range of characteristics. Typical ratios vary from 1:1 FA:PC, to 20:1 FA:PC – depending on the properties required. (See Table 1.)

The other key benefit offered by FA is the improvement in flow and pumping characteristics.

**Table: 1**

Envirocem notation	weight	Typical Compressive strength (M/mm <sup>2</sup> ) at:			
		FA by 3 days	7 days	28 days	90 days
EGP 1	1:1	11.0	17.5	35	50
EGP 3	3:1	4.0	7.0	10	15
EGP 5	5:1	2.5	3.5	5.5	6.0
EGP 10	10:1	1.0	1.5	2.0	2.5
EGP 15	15:1	1.0	1.0	1.5	2.0
EGP 20	20:1	0.5	0.5	1.0	1.5

*Strengths are based on a water/solid ratio of 0.4*

### Characteristics of the FA in Envirocem Grouts

Envirocem General Purpose Grouts have unique properties, most of which are related to the characteristics of the FA. The FA particles consist mainly of hollow spheres between one and 150 microns in size. These form a continuous grading which allows FA to improve the rheological properties of grout. FA is composed essentially of alumina, silica and iron oxide, the same as in Portland Cement, although in contrasting and complementary proportions.

This allows FA to react pozzolanically and, depending on the Portland Cement content, this will produce a denser, less permeable grout. Leachates are, therefore, reduced, as is the transmission of any contained ionic or aqueous species. Envirocem FA has a specific gravity of approximately 2.1 kg/m<sup>3</sup>, about two thirds that of Portland Cement.

### Properties and Advantages of FA : Portland Cement Envirocem Grouts

The principal advantages to be gained from the use of FA grouts are as follows:

- Economy (through increased volume)
- Reduced water/solids ratio
- Increasing compressive strength
- Reduced bleeding
- Increased yield
- Reduced shrinkage
- Reduced permeability
- Increased resistance to chemical attack (sulfate)
- Improved flow properties
- Setting time.

## Economy

FA acts as a filler, replacing sand, thereby improving flow properties and penetration without limiting the size of cracks or fissures that can be injected.

FA – particularly Envirocem FA – is extremely light which significantly increases the yield per unit weight. Details of the material requirements to produce one cubic metre of hardened grout are shown in Table 2.

**Table 2 – Typical Yield information**

Envirocem notation	Typical weight of constituent materials to produce 1m <sup>3</sup> of hardened grout at a water solids ratio of 0.4				Typical yield/tonne
	fa/Kg	cement /Kg	water /litres	Envirocem grout/tonne	
EGP 1	630	630	500	1.26	0.797m <sup>2</sup>
EGP 3	890	300	475	1.19	0.837m <sup>2</sup>
EGP 5	980	200	470	1.18	0.850m <sup>2</sup>
EGP 10	1055	105	46	1.16	0.860m <sup>2</sup>
EGP 15	1080	72	460	1.15	0.867m <sup>2</sup>
EGP 20	1090	53	460	1.14	0.868m <sup>2</sup>
cement grout	0	1387	555	-	0.720m <sup>2</sup>

### Reduced Water/Solids Ratio

The predominantly spherical shape of FA particles imparts a lubricating effect to grouts, resulting in a lower water/solids ratio. This is very important as water has a significant effect on the properties of grout both before and after setting.

An excess of water results in increased bleeding, lower strengths and durability. It is therefore very significant that the use of FA lowers the water/solids ratio. In general the water/solid ratio of FA:PC grouts range between 0.35 – 0.5 by weight.

### Increasing Compressive Strength

The absence of coarse aggregate in grouts limits the attainable compressive strength compared with concrete. However the slower but longer-term gain in strength of FA:PC grouts can be utilised beneficially and economically and strengths up to 50N/mm<sup>2</sup> can be obtained at 90 days. The strength does continue to increase with further time.

### Reduced Bleeding

The addition of FA has a marked improvement on the stability of grout suspensions. This is due not only to the lower specific gravity of FA, but also the ability of the particles to attract and retain water on their surfaces. This results in typical reductions in both rate of bleed and the bleed capacity.

### Increased Yield

The lower specific gravity of Envirocem FA, which ranges from 2.0-2.2kg/m<sup>3</sup> will produce higher volumes per unit weight when compared with cement (3.14kg/m<sup>3</sup>) and sand (2.6kg/m<sup>3</sup>) mixes. Thus, less material is required and, therefore, a reduction in cost when prices are assessed by volume. (See Table 2.)

### **Reduced Shrinkage**

It has been established through thorough laboratory tests that there is negligible shrinkage in FA:PC grouts when tested at a water/solids ratio less than 0.4.

### **Reduced Permeability**

The pozzolanic reaction that takes place between the FA and cement precipitates gel products, which act as a blocking mechanism within the capillary pore matrix of the grout.

Envirocem Grouts at a water/solid ratio of not more than 0.4 have recorded permeability values of  $1.3 \times 10^{-8}$  m/s.

### **Increased Resistance To Chemical Attack**

Sulfates attack Portland Cement Grouts by reacting with calcium hydroxide and calcium aluminates, resulting in volume increase and therefore destruction.

The replacement of cement by FA in the grout results in the reduction of the level of tri-calcium aluminate which is susceptible to sulfate attack. Moreover, the pozzolanic reaction reduces the amount of calcium hydroxide which again increases resistance to sulfate attack. The reduced water/solids ratio achievable with FA-based grouts means that the permeability of the grout is reduced which restricts the movement of aggressive agents into the grout.

### **Improved Flow Properties**

Grout workability is normally measured by a viscometer using the Bingham fluid characteristics. The twin advantages of the well-graded and rounded particles of FA improve both yield stress and viscosity.

Empirical results using the Colcrete Flowmeter or Marsh Cone suggest that FA grouts with a flow value of 300mm (12 inches) or above provide a grout with excellent pumpability characteristics

### **Setting Time**

Envirocem Grouts tend to have a slower rate of set than Portland Cement grout. The overall strength development can, for practical purposes, be considered similar, although at very high FA contents this is at a slightly slower rate and therefore the 90-day result is a better guide to their strength than the 28-day result.

### **Envirocem Grout Benefits**

Because Envirocem's raw material is a by-product, our products are sustainable.

They conserve primary aggregates, they avoid the need to landfill ash – and by displacing carbon-intensive Portland Cement and other aggregates that require energy to produce, they save CO<sub>2</sub> emissions.

Envirocem Grouts are low density, so less material needs to be used, and because it is lightweight, this can result in a significant reduction in the number of vehicle movements needed to transport materials onto site – reducing fuel use and emissions.

In addition, Envirocem Grouts require less water than conventional grouts, helping to reduce a project's water footprint.

Envirocem's environmental credentials have been recognised with a number of awards over the years, including a Queen's Award in the Sustainable Development category in 2008, Environmental Big Tick awards from Business in the Community and several VIBES (Vision in Business for the Environment of Scotland) awards.

In September 2008 Envirocem was listed on the CleanTech 100, an index compiled by Library House and The Guardian newspaper described as "the official list of Europe's hottest green companies".

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March 2021