



# Technical Datasheet

## Fly ash in Pavement Construction – FABM 1 (Fly ash bound granular material)

### Introduction

Fly ash can be used in variety of ways within highway construction, the aims being;

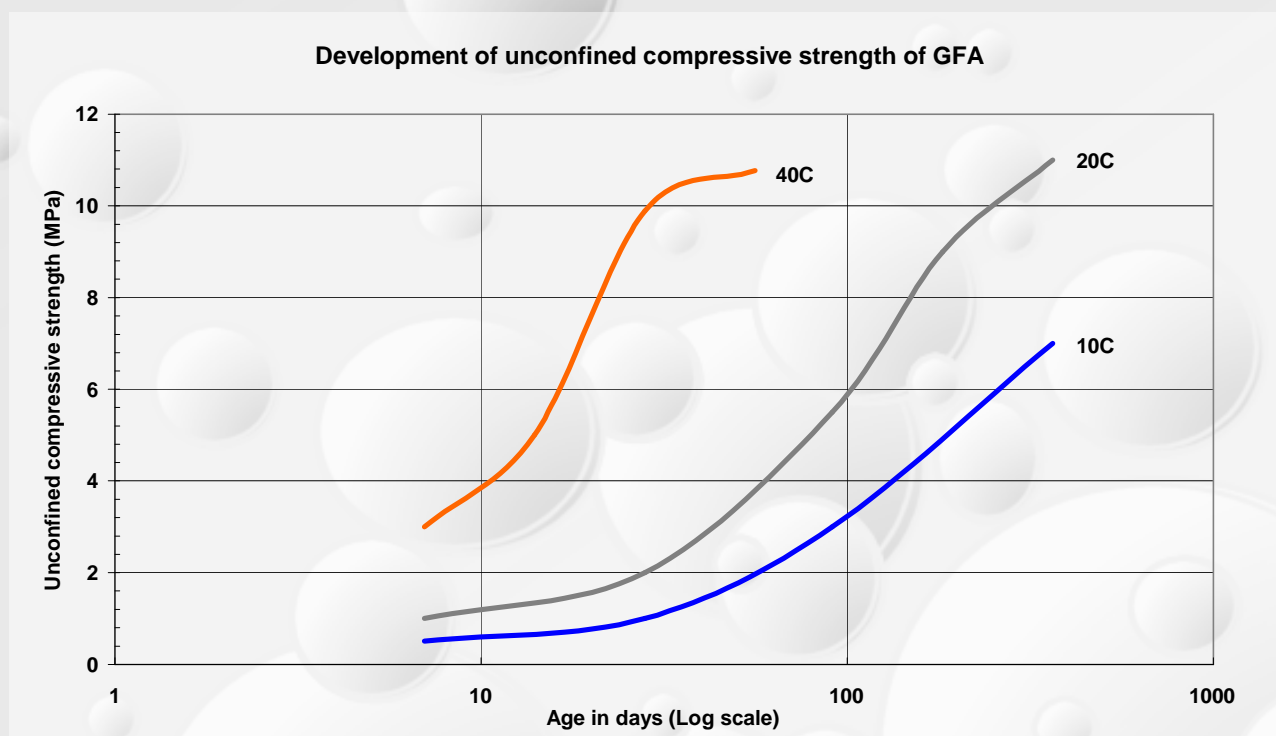
- To use fly ash, a by-product from coal-fired power generation plants.
- To reduce the consumption of primary materials for pavement construction.
- To widen the range of pavement construction materials.
- To produce cost effective, sustainable, pavements.

This data sheet describes the characteristics, behaviour and use of 'granular material treated with fly ash & lime', standardised in BS EN 14227-3 as fly ash bound mixture 1 (FABM 1).

### FABM 1 (known historically as GFA – Granular material treated with Fly Ash)

FABM 1 is a mixture of coarse and fine aggregates, which is used in combination with lime, water and fly ash - or Pulverised Fuel Ash (PFA) as it is also called in the United Kingdom. It is produced with sufficient moisture to enable compaction with a roller, in a similar way to cement bound materials. Fly ash is a pozzolanic material and in combination with lime acts as a hydraulic binder.

FABM 1 relies on this pozzolanic reaction between the lime and the PFA to produce its long-term strength characteristics as shown in Figure 1, which shows results for GFA. FABM1 can be used for sub-bases and bases of all classes of road & airfield pavements and footways.



**Figure 1 – Compressive Strength of GFA.**

### Characteristics, performance & durability

FABM 1 is a slow-hardening mixture, which progresses from behaving like an unbound crushed stone material into a bound paving material, the rate of reaction being strongly dependent upon temperature (see Figure 1). This has advantages in road construction:

- In the short term, FABM 1 has a handling time of many hours and thus the flexibility of unbound granular paving materials.
- In the long term and depending on the aggregate, FABM 1 develops significant elastic stiffness (10-30 GPa) and tensile strength (1 - 3MPa) and produces a pavement material with the performance and durability of bituminous and cement-bound materials.
- The slow reaction rate gives extended workability, permits immediate accessibility to site traffic and the capacity of self-healing.
- In the fresh condition on normal sites, the correct grading framework for the FABM 1 produces a tight closed finish that can withstand rain.
- On hilly sites, the fines in the fresh FABM 1 can be removed by rain-water and measures should be taken to prevent this occurring.
- The use of crushed material and the correct grading framework is responsible for the immediate traffickability of FABM 1 and thus its stability over the short and medium-term which at the same time permits the stiffness and strength to develop unimpaired.
- The reduced lack of reflective cracking found with FABM1 is largely due to the slower gain in strength.
- The ultimate structural characteristics continue to develop 2 to 3 years after laying.
- The preferred laying season is April to October inclusive. If laid outside this period, it is imperative to protect the material from the weather by the placement of the overlying layers, preferable before set commences, typically therefore within 3 days.

**Mix composition:** Mix composition depends on the materials available and the figures given in Table 1 are illustrative only.

<i><b>FABM</b></i>	<i><b>Conditioned fly ash</b></i>	<i><b>CaO or Ca(OH)<sub>2</sub>*</b></i>	<i><b>CEM I</b></i>	<i><b>Graded coarse aggregate**</b></i>	<i><b>Fine aggregate**</b></i>	<i><b>Soil</b></i>	<i><b>Typical water content (%)</b></i>
<b>1</b>	8.5 – 13	1.5 – 3	-	50 – 55	30 - 40	-	6 – 8
<b>1</b>	6 - 8 (dry*)	1.5*	-	50 – 55	35 – 40	-	5 – 7
<b>1</b>	6 – 8	-	2 – 4	50 – 55	35 - 40	-	6 – 8

**Table 1: Typical mix proportions for FABM 1**

\* Lime and dry ash may be pre-blended at works.

\*\* Natural, reclaimed or by-product material

**Manufacture:** FABM 1 is batched and produced by weight in central batching plants equipped with continuous pug-mill mixers.

**Laying:** Placement and compaction is by conventional plant such as drot, grader, paver and vibrating roller. Pneumatic-tyred rollers are usually specified for finishing purposes. Immediately after compaction, FABM 1 shall be prevented from drying out by the application of an alkaline bitumen emulsion or the repeated light-spray application of water.

**Utilisation:** FABM 1 can be used as sub-base/ base under bituminous or pavement quality concrete surfacing. Whatever the case, the FABM 1 shall be laid on a sub-grade, capping or sub-base material with a soaked laboratory CBR of at least 15%. The thickness of FABM 1 and surfacing is a function of the ultimate structural properties of the FABM 1 and traffic and shall be determined by an experienced pavement engineer (Data Sheet 6.3)

## Bibliography

- BS EN 14227-3. Hydraulically bound mixtures – Specifications – Part 3: Fly ash bound mixtures. BSI, London, UK.
- BS EN 14227-4. Hydraulically bound mixtures – Specifications – Part 4: Fly ash for hydraulically bound mixtures. BSI, London, UK.
- BS EN 14227-14. Hydraulically bound mixtures – Specifications – Part 14: Soil treated by fly ash. BSI, London, UK.
- UKQAA data sheets;
  - 6.0 Fly ash in pavement construction – Overview of FABM & SFA
  - 6.1.1 Fly ash in pavement construction – FABM 1 (fly ash bound granular material)
  - 6.1.2 Fly ash in pavement construction – FABM 5 (treated fly ash)
  - 6.1.3 Fly ash in pavement construction – SFA (soil treated with fly ash)
  - 6.2 Fly ash in pavement construction – Laboratory mixture design for FABM & SFA
  - 6.3 Fly ash in pavement construction – Thickness design using FABM 1 & FABM 5
  - 6.4.1 Fly ash in pavement construction – Specification for FABM 1
  - 6.4.2 Fly ash in pavement construction – Specification for FABM 5
  - 6.4.3 Fly ash in pavement construction – Specification for SFA
  - 6.5 Fly ash in pavement construction – Fly ash & lime stabilised clays – preventing sulfate heave

In general usage the term 'fly ash' is used for pulverized coal ash but it can also cover ash from burning other materials. Such 'fly ash' may have significantly differing properties and might not offer the same advantages as ash from burning pulverized coal. UKQAA datasheets only refer to PFA / fly ash produced from the burning of predominantly coal in power stations.

Information provided in this document is intended for those who will evaluate its significance and take responsibility for its use and application. UKQAA will accept no liability (including that for negligence) for any loss resulting from the advice or information contained in this document. It is up to the user to ensure they obtain the latest version of this document as the UKQAA continually revises and updates its publications. Advice should be taken from a competent person before taking or refraining from any action as a result of the comments in this guide which is only intended as a brief introduction to the subject.

Version 1.0 May 2011