UNITED KINGDOM QUALITY ASH ASSOCIATION

Technical Datasheet

Fly ash in Pavement Construction – FABM 5 (Treated fly ash)

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 fly ash treated with either lime or cement, standardised in BS EN 14227-3 as fly ash bound mixture 5 (FABM5).

FABM 5

FABM 5 is a fly ash treated with either;

- lime (the resulting mixture sometimes known as LFA) or
- cement (the resulting mixture known as CFA).

The fly ash is part binder and part aggregate in such formulations. Whilst needing more care than other FABM in placing and compaction, FABM5 is economically and environmentally attractive as it consists mainly of by-product material.

Mix composition, performance, durability & utilisation

Various compositions can be used depending on the source and reactivity of the constituents and the design requirements. The examples given in Table 1 are illustrative only and exact FABM 5 mixture proportions should be determined in laboratory trial mixes.

Table 1: Compressive strength in MPa for FABM 5 (LFA & CFA) at 20C

Sealed specimens	*LFA with 2.5% CaO*	*LFA with 5% CaO*	*CFA with 7% PC*	*CFA with 9% PC*
7 days	1.5	1.8	3.0	5.0
28 days	---	---	4.0	8.0
35 days	4.0	4.0	---	---
28 days + 7 days in water	3.3	3.3	---	---
91 days	5.0	7.3	6.0	9.0

Notes:

1. Standard Proctor Optimum Moisture Content (OMC) for mixtures ~ 21%. Typical specimen wet density ~ 1600 Kg/m^3.
2. Mixture percentages are based on dry weight. Thus 2.5% CaO ~ 33 kg/m^3.
3. Strength results are for 1:1 cylinders and can be considered equivalent to cubes.
4. Specimens were cured at 20C and sealed to prevent evaporation.
5. The results at 28 + 7 days designate 28 days curing by sealing followed by 7 days full immersion in water.

The results show the advantage of CEM I over CaO at 7 days but illustrate the superiority of CaO at 91 days. The above results suggest that 5% CaO ~ 8% CEM I are equivalent at later ages.

Even with just 2.5% lime, compressive strength class C3/4 is achievable and soaked strengths are 80% of un-soaked strengths. Such strengths and soaked strengths means that the durability and volume stability of this FABM is assured and that 2.5 % lime can, with proper production methods, produce a mixture suitable for use as sub-base.

However, higher powder contents, say 5% of either lime or cement, are recommended whatever the use including use as lightly-trafficked base.

Construction & Utilisation

General: At optimum moisture content, LFA will support traffic immediately. Surface disturbance will occur but can be rectified with wetting, re-shaping and re-rolling before setting commences. This may be between 2 & 4 days after laying depending on temperature. For best results however, the direct trafficking of LFA should be avoided and it should be overlain, before setting and drying out, by the next layer, the latter being delivered over itself to avoid direct trafficking of the LFA.

CFA on the other hand behaves more like a conventional cement-bound mixture based on CEM I. Thus if overlaying before setting is not possible, usually within 2 to 4 hours depending on temperature, trafficking must be prohibited for 7 days.

Both LFA and CFA need careful attention at the compaction stage and where direct trafficking occurs. Care should be taken to avoid surface shearing and de-lamination, hence the aforementioned advice for trafficking & overlaying.

It should be noted that below 5 degrees C, the reaction between lime and PFA virtually ceases. This is generally not a problem with capping but when LFA is used for sub-base or base applications, its use should be limited to April to September unless the overlying layers / surfacing are laid before the first frosts.

Soft burnt fine grade quick lime or hydrated lime should be used for LFA.

Manufacture: FABM 5 is best produced in pug-mill mixers.

Laying: FABM 5 should be laid 'high' & trimmed by 'tracked' blades, and compacted by pneumatic-tyred roller only.

Utilisation: FABM 5 can be used as sub-base / base under bituminous or pavement quality concrete surfacing in either case, the materials shall be laid on a sub-grade, capping or sub-base material with a soaked laboratory CBR of at least 15%.

Figure 1 - Gotham by-pass, Notts. Compacting CFA.

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.