

Case Study

The use of GFA for the A52 Kingsley to Froghall Reconstruction, Staffordshire

Introduction

GFA is a mixture of crushed graded coarse aggregate, sand, PFA and lime, where the PFA/lime combination performs as a binder. The mixture has a water content compatible for compaction by rolling.

In August 1997, GFA was used for the reconstruction of a 1-km length of the A52 in Staffordshire. The job consisted of:

- the removal, by planing, of a 400mm depth of existing pavement,
- processing and recycling the planings with PFA and lime to produce GFA and
- relaying the pavement using 300mm of GFA under 100mm of new bituminous surfacing.

Tilcon (South) Ltd carried out the contract for Staffordshire County Council.

GFA was chosen for its laying flexibility, immediate stability under traffic, and the development of significant stiffness and strength. These attributes were necessary because access to the site was only possible from either end. Thus any paving material had to be capable of immediate use as well as being able to accommodate the future heavy slow moving in service traffic.

This datasheet describes the design, construction and monitoring of the work.

Pavement design

The section of road requiring repair is known as Kingsley Bank and is a steep winding hilly section of the A52 between Kingsley and Froghall. The road and surrounding area is geologically unstable. Investigation revealed significant distress in the bituminous layers but a relatively sound and strong formation.

In line with their policy on recycling and the use of local industrial by-products, Staffordshire decided to recycle the existing bituminous layers with lime and PFA from Rugeley Power Station.

The design for the reconstruction, based on a formation CBR of 15%, channelised in service traffic of 8 msa, and the above site and construction requirements was:

- 30mm Stone Mastic Asphalt wearing course
- 70mm Dense Bitumen Macadam base course
- 150mm GFA road base
- 150mm GFA sub-base.

Mixture design

Using material recovered from the road during site investigation, potential mixtures were examined in the laboratory, using data sheet 6.2, to establish the lime and PFA addition to satisfy the above. The chosen mixture on a dry basis was:

3% CaO + 12% PFA + 85% planings



Figure 1 - Laying GFA roadbase

It should be noted that 2 and 4% CaO addition gave virtually identical results but 3% was selected for this first application of GFA in the UK. The full results for 3% CaO were as follows:

Age (days)	7	28	60	90	365
E_{it} (GPa)	-	11	-	12	13
R_{it} (MPa)	-	0.6	0.8	1	1.2
R_c (MPa)	1.5	5	9	11	15

Table 1 - Results from trials

The vibrating hammer optimum moisture content (OMC) for the mixture was 7%.

Production, construction & control

1. The existing flexible pavement consisting of 300/400mm bituminous material on stone/cobbles was planed out and taken to a nearby Staffs C.C. depot where it was screened into '20 to 5' and '< 5' mm fractions.
2. Kerbing and drainage work was carried out at the site and the formation tested with the Falling Weight Deflectometer (FWD) and cone penetrometer. This revealed in places that the foundation was weaker than anticipated. Depending on strength and location, these areas were locally excavated to depths of 150 or 350mm to be reinstated with GFA.
3. At the depot, the screened planings, PFA, lime and water were mixed in a continuous pug-mill



Figure 2 – Lay GFA on the A52



Figure 3 - Compacting GFA

mixer and the resulting GFA returned to the site and placed in two '150mm' layers as sub-base and road base. The placing was by conventional paver and compaction by a combination of vibrating and pneumatic tyred (PTR) rollers. The latter was necessary to produce a tight crack-free surface and as a test of GFA under traffic. The finished GFA was kept damp by the application of a fine water spray.

Under the PTR, the GFA proved its stability under tyres and was able to act as an immediate working platform for access and other subsequent operations. This was important since access was restricted to either end of the job and there was no provision for lorries to turn. This meant that freshly laid GFA was immediately trafficked by lorries bringing in fresh GFA and later the surfacing.

4. The weather during the GFA operations was variable. This necessitated tight control of moisture content particularly in the stockpiles. On two occasions, over-wet GFA was laid which was impossible to compact. This was rectified by 'opening-up' the laid GFA using a toothed JCB bucket. This allowed excess water to evaporate and permitted compaction later. This 'opening-up' was possible up to three days after mixing. After this time the GFA began to set and harden.

5. No time restrictions were placed on surfacing operation. Generally bituminous base course was laid within 1 to 3 days after the GFA road base and SMA wearing course followed to suit.
6. During GFA operations, insitu compaction was monitored and test specimens made for strength determination. These confirmed the mix design testing and design assumptions.



The finished product and monitoring

After surfacing but prior to opening, a FWD survey was carried out. This was repeated the following spring and on the anniversary of opening. Deflections were:

Figure 4 - Finished GFA road base ready for surfacing

<i>Deflections (mm x 0.001)</i>	<i>Sept 97, 13 °C</i>	<i>June 98, 18 °C</i>	<i>Sept 98, 14 °C</i>
<i>Total</i>	170	90	80
<i>Subgrade</i>	40	35	35
<i>Pavement</i>	110	35	20/25

Table 2 – Measured deflections in road surface

At the same time as the '1 year' FWD survey in September 1998, 20 No. 150mm diameter cores were taken.

Coring was successful - 100% of cores were recovered.

Core testing gave the following:

<i>E_{it} (GPa)</i>	<i>R_{it} (MPa)</i>	<i>R_c (MPa)</i>
16 (range 11-24)	0.85 (0.6-1.1)	6 (5 - 7)

Table 3 – Results of core tests

Conclusions

- GFA is a slow setting slow hardening mixture which behaves as an unbound material in the short-term but as a bound material in the medium to long term.
- GFA proved ideal for the A52 work with its requirements for full flexibility during construction and significant stiffness and strength in the long-term. Curing was not necessary, immediate trafficking was possible, and as the FWD and coring exercises illustrate, stiffness and strength has developed as anticipated.

- The GFA on the A52 has proved 100% successful. Visually the job looks good. The pavement has the required structural properties and all this has been achieved with a material that comprises -

RECYCLED PLANINGS AND BY-PRODUCT PFA COMPRISES 97% OF THE MIXTURE

Figure 5 - Laying GFA in
the rain



Figure 6 - Laying and compaction
of GFA for a French motorway

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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 fly ash / fly ash produced from the burning of coal in power stations.

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