Summary

Staffordshire County Council (SCC), ACCORD Operations Ltd. and Wrekin construction have been involved with construction, maintenance and recycling of asphalt pavements over a number of years. The partnership ‘Staffordshire Highways’ was formed in April 2004 as a result of the council’s ‘Best Value Review’. (The partnership encompasses the principles outlined in the Egan and Latham reports). Within the partnership, ACCORD are principally responsible for maintenance works, whereas Wrekin Construction are primarily responsible for new construction works. However, some of most important issues identified during the case study investigation are as follows:
With a partnership arrangement, Early Contractor Involvement (ECI) is inevitable and an integral part of the planning and design process. This arrangement allows effective project planning and resolution of potential problems before they arise.

Partnering provides a means whereby medium to long-term planning is possible, thereby enabling organisations to develop appropriate resources to deal with work that arises.

Construction using GFA is relatively straightforward and does not require specialised equipment.

To achieve a good GFA mixture, careful attention to the grading requirements is required.

The case study is illustrated by two schemes: one using GFA for new construction and one where Foamix has been used in maintaining a local road.

**Supply chain**

The supply chain is mainly client (Staffordshire CC) driven, one of the results of setting up the partnership is that a generally perceived obstacle for the use of recycled materials has been removed - i.e. a lack of specifications for innovative materials and techniques such as GFA or Foamix. Collaboration between the three partners has led to a joint understanding of issues around specifying and construction of GFA materials. This has led to more effective coordination of resources such as the location and use of mobile recycling plants, and prediction/provision of planings/RSA (Recycled and Secondary Aggregates). A net result is that recycled materials can be used more often, especially on smaller contracts.

Rationalisation of the supply chain followed analysis of the Best Value Review findings where it was recognised that the number of contractors used was excessive, making coordination of different aspects of some contracts difficult and procurement expensive. Also there was little collaboration between design and construction teams, leading to inefficiencies. The proposed partnership offered perceived benefits where early involvement of the contractor helps remove potential obstacles and pitfalls and encourages value engineering. The relationship between the parties pre- and post partnership is illustrated in Figures 1 and 2. The two term contracts encompass all of the maintenance and construction works previously undertaken through a multiplicity of contracts.
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Figure 1  Schematic representation of pre-partnership arrangement

Staffordshire CC Development Services

Highway Management Services
- Highways Maintenance Term Contractor
- Highway recycling operations
- Depot based recycling of maintenance arisings for granular sub-
- Manufacture and use of Foamix material using carriageway planings

Staffordshire Engineering Services
- Engineering Services Laboratory
- Bridge Maintenance and Strengthening Works
- Highway Design Service
- Integrated Transport works
- Procurement and supervision of highway construction services

Recycling works undertaken on a scheme specific basis, principally using granular fly ash
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Figure 2  Schematic representation of partnership arrangement

Staffordshire Highways

Management Board
Accord, Wrekin and SCC representation

Operations Board
Accord, Wrekin and SCC representation

Accord operations Ltd
Wrekin Construction Ltd
Staffordshire Engineering Services
Highway Management Services
The partnership agreement provides ACCORD with a five-year term that can be extended to ten years, and Wrekin with a three year agreement that may be extended to five years. Extensions to the basic contract period will be justified via a rigorous performance management regime. Various benefits are obtained using this approach.

A more predictable workload gives incentive to the partnership to develop specifications and working practices that in turn lead to more recycling schemes being carried out. This is particularly true for smaller contracts that under conventional contractual arrangements would often be too small to be cost effective and for a contractor to invest time developing an acceptable specification.

Flexibility and interaction of the Wrekin and Accord organisations are key factors in the success of the partnership. In particular there are few well-defined boundaries between the capabilities of the two contractors. This means that if a surfeit of maintenance works are to be carried out and little new construction, for example, Wrekin can carry out some of the maintenance works (and vice-versa). Figure 3 illustrates how the two organisations complement each other in generating and using materials during the course of their work.
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Figure 3  Working relationships between Accord and Wrekin

**MAINTENANCE**

**ACCORD Construction Ltd**
- Sale of surplus GSB to third parties
- Sale of surplus planings to quarries
- Recycling maintenance arising for granular sub base (GSB)
- Production of Foamix and GFA materials (Lime Planings Cement)
- Carriageway Planing and Resurfacing

- Central Programming Unit (Virtual Team)
  - Provision of GSB
  - Transfer of construction and maintenance arisings for maintenance
  - Exchange of Foamix and GFA materials
  - Exchange of Planings

**Staffordshire County Council Maintenance and Construction Programmes**

- Use of GSB
- Production of Granular Fly Ash (GFA-PFA, Lime, Planings)
- Carriageway Planing and resurfacing

- Wrekin Construction Ltd

**NEW CONSTRUCTION**

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Aggregates Case Study:
Recycling in highway construction and maintenance enabled by partnering in Staffordshire
Case Study 1 - New Construction

Background

The first case study describes issues relating to a new single carriageway road approximately 1300m long that is being built to serve the Kingswood Lakeside Development. The location of the scheme is seen in Figure 4.

The proposed pavement structure incorporates Granulated Fly Ash (GFA), which is a mixture comprising Pulverized Fuel Ash (PFA), cement or lime, aggregates and water. It is easily placed with either a paver, or (more commonly) with a tracked excavator, and has been successfully laid in both wet and dry conditions. Compaction can be carried out with steel or pneumatic rollers. A key driver for the use of GFA is the experience that the contractor (Wrekin Construction) and Staffordshire County Council have of using the material over more than five years, and the local source of PFA.

Figure 4 Location of the Kingswood Lakeside site and associated sites
Pavement construction

The bound pavement layers are due to be constructed in March 2005 and form the second and final phase of pavement works. Phase II of the pavement works will partly comprise GFA as indicated in Figure 5. The pavement construction in Phase I followed a conventional design using ‘traditional’ materials.

Figure 5  Pavement structures – Kingswood Lakeside

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Conventional)</td>
<td>Construction incorporating GFA</td>
</tr>
<tr>
<td>40mm surface course</td>
<td>40mm surface course</td>
</tr>
<tr>
<td>60mm binder course</td>
<td>60mm binder course</td>
</tr>
<tr>
<td>200mm base course</td>
<td>350mm GFA base and sub-base course</td>
</tr>
<tr>
<td>150mm Type 1 granular sub-base</td>
<td></td>
</tr>
<tr>
<td>Class 1 foundation</td>
<td></td>
</tr>
</tbody>
</table>

The recycling option has been chosen partly due to the availability of planings from a nearby site on the A34, where asphalt and CBM materials have been replaced to a depth of 300mm. The mixing plant was located in the Pottal Pool quarry that is approximately 13km from the A34 site and around 8km from both the Kingswood Lakeside development site and the Rugeley Bypass site that is also under development and being designed with GFA layers. PFA is sourced from the nearby Rugeley power station.

Specification and Design

Specifications for the works were developed from experience of previous contracts (see other case studies from the West Midlands on the AggRegain website), and around recommendations made in TRL611 (Merrill, Nunn and Carswell, 2004).
Traffic

The traffic was estimated as being around 5-7 msa for the Lakeside scheme and between 8 and 12 msa for the Rugeley By Pass. Both volumes of traffic are well within an acceptable design range for recycled materials.

Benefits

Technical

Construction

No special plant is required for construction of a GFA pavement, and as the material is slow curing the material can be placed in a variety of weather conditions over several hours. In previous contracts effective placement of the material has been carried out using tracked excavators, and compacted using either steel vibrating rollers or pneumatic tyred rollers. Placing materials with a paver is also possible but has been found to cause excessive wear. Figures 6 and 7 show GFA being laid with a paver on the Burntwood bypass.

Although specialised plant is used to place Foamix, it is becoming relatively easy to procure, as more companies invest in new technologies.

Figure 6   Laying GFA with a conventional paver on the Burntwood bypass
Early trafficking

On earlier projects using similar materials GFA has been shown to perform well enough to permit trafficking immediately after laying, providing traffic is not exceptionally heavy and an adequate proportion of crushed aggregate is used. As a rule of thumb it appears that if the material is strong enough for the construction plant to lay the surfacing, it is sufficient to carry traffic.

Cost

As the planings from the A34 would have had to be removed from the site to a quarry, disposal site or a recycling plant, 85% of the aggregate was effectively free, leading to an approximate overall 40% direct cost saving on the base and sub-base layers.

Other indirect savings are found in environmentally-linked costs such as a reduction in the energy that would have been used to extract, crush and heat aggregates for ‘hot mix materials’ (HMA).

If materials are placed with tracked excavators fewer staff are required than for a typical paver.

Environmental

Energy

The option of new reconstruction would have meant an additional 3460 tonnes of ‘fresh’ asphalt being used, i.e. with an approximate 2940 tonnes of virgin aggregate.
Published information on energy usage in production, transportation and laying suggests that the use of the PFA as a binder in the GFA was a more energy efficient option than the normal use of cement or use of bituminous material.

It is estimated that the total energy of mixing and laying the GFA is around 695 Gj compared to 1,400 Gj using the conventional hot mix asphalt solution.

**Efficient use of resources**

At present several millions of tons of PFA are produced by the power stations each year, and much of this is landfilled. GFA is one means of making good use of this valuable material.

**Congestion**

The use of GFA and planings from the A34 will result in fewer truck movements than if hot mix materials (HMA) are brought from Derbyshire, which is the usual source of asphalt for this district.

**Disposal of material**

Similarly to the points made for congestion, reuse of material reduces the amount of material that has to be disposed, resulting in savings on transport and landfill costs and the conservation of limited landfill capacity within the County.

**Regulatory issues**

Planning consent had already obtained from the local authority, and a waste management licensing exemption from the Environment Agency was sought and approved for importing into, and storage of planings in the quarry, and mixing planings into GFA.

**Case Study 2 -**

**Haunching of Moat Lane, Newborough**

**Background**

The Moat Lane recycling contract was carried out on a 1.2km length of 3.1m wide Class C rural road in the East Staffordshire District. The road is typically used by a variety of traffic: light traffic for the village, agricultural traffic, traffic serving an agricultural engineering business manufacturing boilers and heating equipment, and 20-tonne trucks of an aggregate haulage company operating from a depot on Moat Lane.

The majority of the road loading is from haulage vehicles whose depot is located on the road. As a consequence of edge breaks and damage the road required to be repaired and
widened. The haunches were repaired by stabilisation with cement and the pavement and haunches resurfaced with foamix and a surface dressing in July/August 2004.

The structure of the pavement (pre-haunching) is shown in Figure 6

**Figure 6 Pre-haunching pavement structure at Moat Lane**

![Diagram showing pavement structure](image)

### Pavement problems: reason for haunching/widening

The pavement was widened and resurfaced due mainly to damage to the soft edges of the carriageway. In addition, a number of failed pothole patches were present, as was an 'old' surface dressing.

The damage to the edge of the pavement was caused by a combination of heavy goods vehicles and agricultural plant that have tended to run off the carriageway edge, poor carriageway drainage and surface water run-off from adjacent land. Due to the standing water the pavement has also been subject to frost damage. Stabilisation of the existing soils in the haunches with cement was chosen as a more sustainable option than excavation and replacement with primary aggregates.

Foamix was selected for use as a result of the general appreciation of the need for sustainable practices (one of the findings of the best value review) and the Moat Lane works also provided the opportunity to extend its use beyond new construction into maintenance. Foamix is a term commonly used to describe cold lay asphalt with a binder consisting predominantly of foamed bitumen. Foamed bitumen is produced by the injection of 1 to 2% cold water with air into hot penetration grade bitumen. This process produces a high-volume, low viscosity fluid with low surface tension; these properties enable the foamed
bitumen to coat a wide range of moist, cold recycled aggregates. Foamed bitumen can be used for in situ and ex situ recycling, which allows the use of other recycled or secondary materials as the coarse aggregate. Hydraulic binders can be added to vary the properties of the asphalt product. Materials bound with foamed bitumen, on its own or with lime and pulverized-fuel ash, are highly workable; they can be stockpiled or reworked if necessary up to 48 hours after production. For an increased rate of curing, foamed bitumen can be combined with Portland cement or other hydraulic binder.

**Haunch design**

The new (haunched) pavement construction is shown in Figure 7. Design was based around Clause 948 of the Specification for Highway Works. As the design was carried out prior to the publication of TRL611, layer thicknesses were selected using previous experience with foamix and engineering judgement.

**Figure 7 ‘New’ (haunched) pavement structure**
French drains were also installed to remove water at low spots and verges were regarded to allow water to drain away from the carriageway.

**Benefits**

**Financial**

An estimate of a 20% saving over ‘conventional’ haunching was realised as the materials were cheaper than conventional virgin aggregate materials, there were no landfill costs, and the execution of the work was quicker than for a conventional treatment.

In addition to the above direct savings on this project, it is likely that having trialled the technique and dealt with various operational problems (see below), further cost savings will be realised on future jobs where similar techniques are employed.

**Technical**

The works have provided a useful opportunity to test the benefits of in-situ recycling for maintenance works as opposed to new construction which is the normal situation where recycling is carried out. To date the pavement is performing well structurally, with the only sign of defects being localised de-bonding of the surface dressing. It is thought that this may be due in part to insufficient bonding of the tack coat between the surface dressing and the foamix.

**Concluding Comments**

The two case studies presented illustrate how two types of recycling can be carried out effectively, as compared to conventional construction. One of the key findings of the study was the positive effect that the organisational structure had on the overall works programme. The partnership ‘Staffordshire Highways’ was formed in April 2004 as a result of the council’s ‘Best Value Review’ and encompasses the principles outlined in the Egan and Latham reports. Within the partnership, ACCORD are principally responsible for maintenance works, whereas Wrekin Construction are primarily responsible for new construction works.

The positive effect of the partnership was manifested in various ways:

- Coordination of both organisations in respect of effective and sustainable use of materials excavated during road schemes.
- Early Contractor Involvement (ECI) is inevitable and an integral part of the planning and design process with a partnership arrangement. This arrangement allows effective project planning and resolution of potential problems before they arise.
- Partnering provides a means facilitating medium to long-term planning, thereby enabling organisations to develop appropriate resources to deal with work that arises.
Other points noted during works on the two sites include the following:

- Construction using GFA is relatively straightforward and does not require specialised equipment.
- To achieve good GFA and Foamix materials, careful attention to material specifications is required.
- Direct savings of between 20% and 40% are estimated.
- The combination of cement stabilisation, Foamix binder course and surface dressing were judged to provide a cost effective, short duration and environmentally sustainable solution, to a problem which is typical of a number of rural roads in Staffordshire.

References

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Details of Parties

Client

Staffordshire County Council: (Staffordshire Highways)

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Alistair Scales  01785 276565

The County Council serves a population of just over 800,000 people and maintains around 6,000 km of roads. Under the Local Agenda 21 policy, use of GFA and Foamix fits very well with Theme 2:- 'A Thriving Economy' and Theme 5:- A Sustainable Environment, as the combination of these themes state the intent of maintaining an appropriate highway infrastructure whilst minimising the impact of waste by reusing materials wherever possible.

Main contractors

Wrekin Construction

Gary Morris  01785 854022

Wrekin Construction Limited has a workforce of over 600 permanent employees throughout England and Wales and is involved in most areas of infrastructure provision. Wrekin have been successfully using GFA for around four years, especially in the West Midlands.

Accord Operations Ltd

Andy Ward  01743 273500

Accord is one of the largest providers of term contract and integrated highway maintenance services in the UK. It has been a provider of highway maintenance and improvement services to the Highways Agency for over 6 years, and provides term contract and highway management services to several local authority highways departments.
This case study was developed for WRAP by TRL

Published by:

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