Case Study 5   Recycled and secondary aggregate use in the construction of a household waste recycling centre and access road at Bar End Winchester

Construction Project: Pavements - roads, car parks, etc.

Application: General granular fill
Capping
Selected granular fill: backfill to structures
Unbound sub-base
Concrete surface slab
Bitumen bound binder course
Bitumen bound base

Product: Class 1A Well graded granular material
Class 6F3 Selected granular material
Class 6F2 Selected granular material (coarse grading)
Class 6P Selected granular material
Type 1 Granular sub-base material
Type 4 Granular sub-base material
Cold recycled bitumen bound binder course material
Cold recycled bitumen bound base material
BS EN 12620 aggregate Grade 0/20

Material: Recycled aggregate
Recycled asphalt
Incinerator bottom ash
Spent railway ballast

Region: South East

Title: Recycled and secondary aggregate use in the construction of a Household Waste Recycling Centre and Access Road at Bar End Winchester

Date: June 2004 to December 2004

Client: Hampshire County Council, Environment Department, Waste Management Group

Contractor: Natta Building Company

Designer: Hampshire County Council Engineering Consultancy

Recycled Aggregate: Onyx/ Foster Yeoman

Supplier: Local Suppliers
Reused material on site


Conditions of Contract: ICE 7th Edition Conditions of Contract for Civil Engineering, with Foster Yeoman as nominated subcontractor for the supply of foamix.
Summary

Hampshire County Council (HCC) wished to build a new household waste recycling centre (HWRC) to serve Winchester on a previously developed site at Bar End. The use of recycled aggregates in the construction of the HWRC and access road has been maximised by the client insisting on the use of recycled materials. HCC wanted the project to be an example of how the council should work on future developments. The engineering consultant was involved at an early stage and tasked with designing recycled aggregates into the project. Specifications were adapted where necessary to enable the use of recycled and secondary aggregates. Demolition material from the previous development and car park remained on site and was reused in the HWRC and access road. Involvement of Foster Yeoman and Onyx through other HCC initiatives led to the use of processed incinerator bottom ash (IBA) as coarse aggregate in the base and binder layers of the access road using foamix. Foamix is a term commonly used to describe cold lay asphalt with a binder consisting predominantly of foamed bitumen. It can be used for in situ recycling or in ex situ applications; this allows the use of other recycled or secondary materials as the coarse aggregate, such as IBA in this case study.

Recycled aggregate and spent railway ballast was imported for use in earthworks and the concrete base slab of the HWRC was constructed using recycled aggregate as 15% of the coarse aggregate. Close liaison was maintained with the Environment Agency to resolve any environmental concerns or regulatory issues over the use of IBA. The project illustrates how the use of recycled and secondary aggregates can be maximised when the client provides a clear brief, the designer actively specifies alternative materials, the contractor presses his suppliers to provide the required materials and the client and contractors site staff work together to achieve a satisfactory quality of construction.

Background

Hampshire County Council (HCC) is responsible for the disposal of the waste produced by the 1.6 million residents in the county. There are 26 household waste recycling centres (HWRC) within the county of which 24 are HCC responsibility. The majority were built in the 1970’s and were in need of some upgrading. Some required maintenance and others needed to be pulled down and a replacement built elsewhere. In 2000 it was decided that a site would be needed for a new HWRC to serve the Winchester area. This was the fourth new HWRC to be built as part of this programme. The site, at Bar End was owned by HCC and was a brownfield site. The businesses on site had plans to move off the site in the near future so the site would be left empty. The site was chosen as a new location for the HWRC. The HWRC site is approximately 1 acre with a 300m long access road (see figure 1).

The form of the HWRC is a circular concrete slab as the lower level, on which the containers for the recycled materials will be placed, with concrete retaining walls rising to an upper level where cars will park and from where materials can be placed in the containers. There will be a one-way road system for cars around this upper level. The access road runs for 300 m from the end of the public road at the edge of Bar End Industrial Estate to the HWRC. It is on sloping ground and required a sheet pile retaining wall on the downslope side for the first 100 m from the public road. A schematic cross section through the access road is shown on Figure 2.
As well as maximising the use of recycled aggregates, the site incorporates a number of other sustainability features. These include a sustainable urban drainage system (SUDS) that will take all the runoff from the site and the access road. All the runoff will be allowed to infiltrate into the ground through swales and a balancing pond with storage capacity for the 1 in 100 year storm.

The client (the Waste Management Group in the Environment Department of HCC) made it clear to the Engineering consultancy that the project was to be a demonstration project for sustainable construction techniques. This included using recycled and secondary aggregates.
in the construction where practicable. The designer therefore specified the materials that were permitted and the method of treatment for site won materials to allow them to be used within the permanent works.

Within Hampshire three new incinerators are to be built by the end of 2005. This will result in approximately 100,000 tonnes of Incinerator Bottom Ash arising within the county which needs to be managed. It was decided to use processed IBA arising within the county as the aggregate in the base and binder layers of the asphalt pavement to be used in the access road to the HWRC. A small scale trial with IBA as aggregate in asphalt had been carried out in Hampshire in 2003, and there are examples of the use of IBA in asphalt and concrete from elsewhere in the UK and overseas.

Photograph 1: Stockpiled crushed pavement on site ready for use as granular sub-base.

**Specification, Quality Assurance and Design**

The Specification for the project is the Specification for Highway Works, incorporating the May 2001 amendments. These permit the use of recycled aggregate and asphalt in a wide range of applications including general and selected granular fill and unbound granular sub-base.

The engineering consultant wrote a specific design specification for each different recycled material that was to be used on site. The method statement for the use of IBA in foamix was written in conjunction with Foster Yeoman (FY) and was based on the experience of HCC and FY with foamix in a number of highway maintenance and new works projects, and the small trial with IBA in 2003. 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. The design is based on existing guidance on the use of foamed bitumen in the Specification for Highway Works and recent design guidance for cold recycled bituminous materials produced by TRL as TRL Report 611.

Technical Benefits

A number of technical benefits have arisen by using recycled aggregates on site. The demolition waste and asphalt from the existing car parking was already on site so the crushing and grading were carried out on site using a mobile crushing plant.

The use of recycled aggregates and recycled asphalt in the sub-base and earthworks was praised by the contractor, who stated that they were easier to lay than the equivalent primary materials. The cut-and-fill balance was designed so that as much of the sub-base of the existing car park as possible could be used as recycled aggregate in the new works. There was a requirement for a net import of materials to the site. This was met by recycled aggregates and spent railway ballast from local sources. As well as capping and unbound sub-base, these materials were used as general granular fill and as structural backfill to the retaining wall along the access road and the concrete retaining walls around the base slab of the HWRC. The materials performed very well; they met all specification and quality requirements and were easy to handle and compact.

The use of recycled aggregates in the base slab concrete caused some technical problems in the mix design which were overcome. The concrete is fibre reinforced to prevent shrinkage cracking and incorporated 15% recycled aggregates as the coarse aggregate in the concrete. The concrete has a compressive strength of c25/30 and a maximum aggregate size of 20mm.

The technical benefits of using IBA in foamix were identified by Foster Yeoman as being an easy material to handle which is very consistent in its properties. A programme of testing for the foamix has been prepared to demonstrate that its performance is satisfactory.

All of the works have now been completed with the foamix being laid in early November. The foamix went down very well and there have been no problems with the strength testing that has been carried out. The project was completed to programme and opened on 15th December 2004.

The quantities of recycled materials used on site are shown in table 1.
<table>
<thead>
<tr>
<th>Application</th>
<th>SHW Classification</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chalk imported from adjacent park and ride scheme and rock chalk imported from other construction sites</td>
<td>General Fill</td>
<td>978 m³</td>
</tr>
<tr>
<td>Planed lean-mix, bituminous planings and track ballast from other construction sites</td>
<td>Sub-base and fill to structures</td>
<td>2032 m³</td>
</tr>
<tr>
<td>Recycled aggregates</td>
<td>Fibre reinforced concrete</td>
<td>17.1 m³</td>
</tr>
<tr>
<td>Processing of site won concrete /bituminous material</td>
<td></td>
<td>478 m³</td>
</tr>
<tr>
<td>Crushed concrete/ planings imported from other sites</td>
<td>Class 6F capping layer beneath roads and paved areas</td>
<td>673 m³</td>
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<td>Crushed concrete/ planings imported from other sites</td>
<td>General Fill beneath roads and paved areas</td>
<td>672 m³</td>
</tr>
<tr>
<td>Crushed concrete/ planings imported from other sites</td>
<td>ARRW-Class 6N/ 6P</td>
<td>163 m³</td>
</tr>
<tr>
<td>Crushed concrete/ planings imported from other sites</td>
<td>Sub-base</td>
<td>381 m³</td>
</tr>
<tr>
<td>HWRC RW-</td>
<td>HWRC RW- Class 6N/ 6P</td>
<td>361 m³</td>
</tr>
<tr>
<td>IBA</td>
<td>Foamix</td>
<td>1200t</td>
</tr>
<tr>
<td>Parapets reused from another construction site</td>
<td></td>
<td>80m</td>
</tr>
</tbody>
</table>

*Table 1: Quantities of recycled materials used on site.*
Cost benefits
The cost benefits of this project arose because the recycled aggregates used were from the demolition of the buildings and the existing access road on the site. There were no landfill tax or aggregates levy charges to be paid because all of the material available on site was reused and all the imported materials were recycled or secondary aggregates, and hence not subject to the aggregates levy. This also saved money in the transport cost of bringing primary aggregates onto site. Another saving that was identified was that the crushing machine only had to be brought onto site once. The use of the recycled materials saved money in the subbase and capping layers. The concrete using the recycled materials cost more than if primary materials had been used in the concrete. There were some marginal additional costs in producing the concrete due to design trials and the additional material handling required for blending the RCA with the other coarse aggregates.

Environmental Benefits
The major environmental benefit of this project was the savings in primary aggregates required. In specifying that no primary material could be used as Type 1 material on site a large saving of primary aggregates was made. This also resulted in the use of the demolition material on site so that less waste was generated by this development. This in turn enabled the project to require a lot less lorry movements than if all of the demolition material had needed to be taken away and new primary aggregates had to be brought onto the site.

In Hampshire three new energy from waste plants are to be operational by the end of 2005. This will generate 100,000 tonnes per year of IBA which will need to be utilised or disposed of. This project is acting as a demonstration project on how IBA can be used in construction as a useful resource. If this demonstration project is successful it will provide Hampshire with an alternative to landfill for its IBA.

Supply chain
Hampshire County Council Waste Management Group is the client for the building of the HWRC and access road. They secured the Bar End site about 4 years ago (2000) and drew up an outline for the scheme. They involved HCC Engineering Consultancy in 2002 to design the HWRC and access road. HCC saw this project as an opportunity to demonstrate as many aspects of sustainable construction as possible. The council wanted to lead by example in using recycled materials for a HWRC, showing that it can be done and works as well as using primary materials. They are hoping that by demonstrating the use of recycled aggregates in this project that it will encourage the use of recycled and secondary aggregates in similar applications. If this project is successful they will use more recycled materials in future council projects and it will affect the way contracts are written. See figure 3 for an illustration of the supply chain.

The Engineering Consultancy was tasked with writing the use of secondary and recycled aggregates into the design specification to ensure acceptable performance could be expected. For each of the activities using recycled aggregates a material specific specification was written if the use of the material was not already covered by the existing specification. One of the major parts to the project was that no primary material was to be used for Type 1 subbase.

As this project was proceeding HCC signed a Public Service Agreement with the government in April 2002 until March 2005. The public service agreement requires HCC to achieve more demanding performance targets than would otherwise be expected. One of the targets was to recycle 40,000 tonnes of household, commercial and industrial waste through the
Hampshire Natural Resource Initiative. To achieve this target a working group was set up including individuals, community groups, commerce and industry. The working group included HCC’s term maintenance contractor for highway works, Raynesway Construction Southern Ltd, and the materials supplier Foster Yeoman Ltd.

Foster Yeoman has a new mobile foamix plant which they were prepared to move into Hampshire so that it could be used on road maintenance schemes. It was identified that there would be a large quantity of Incinerator Bottom Ash (IBA) arising within the County. HCC set up an IBA Working Group, involving HCC, Raynesway, Foster Yeoman and the operator of the energy-from-waste plants, Onyx Environmental Group PLC. It was decided that if a demonstration project using IBA as the aggregate in foamix could be undertaken it would be very useful and could be a solution for a new waste stream arising within the county. The HWRC development was on a brownfield site and it was thought that this would be an ideal site for a demonstration project using the material.

Foster Yeoman helped the HCC Engineering Consultancy to develop the method statement for IBA, which was issued with the tender document. Within the design specification it was written that the foamix which was to be used on site had to be supplied by Foster Yeoman and would contain the IBA from Chineham energy from waste plant near Basingstoke. The
was some concern over the commercial implications of this so the price of the foamix was fixed before the specification was sent out for tender.

The contract was put out for tender in February 2004 and was awarded to Natta Building Ltd in May 2004 and work commenced in June 2004. The site had been cleared prior to work starting. Natta Building Ltd were committed to using recycled materials and proceeded to use the materials available on site. There were not enough recycled aggregates available on site to carry out all of the Type 1 sub base work so additional materials needed to be brought in by a number of different suppliers. Recycled aggregates were brought on site from local suppliers. Natta had a contract with RMC to supply them with the concrete containing recycled aggregates for the base of the HWRC.

Onyx stockpiled 1200 tonnes of IBA at the Rainham Marshes landfill site in Essex. The IBA was weathered for at least three months and testing was undertaken to ensure the quality of the ash. Onyx processed the IBA to remove impurities, screened and graded the material to ensure the correct size and quality for use in the foamix. The processed IBA was delivered to the Foster Yeoman depot at Micheldever and mixed with the other ingredients to form the foamix used in the base and binder course of the access road.

The project has proceeded very successfully to date and the HWRC opened on 15th December. The project illustrates the benefits of a collaborative approach, whereby various departments within HCC and other parties in the PSA and IBA Working Groups interacted positively to suggest possibilities and overcome potential obstacles. The strong lead given by HCC on sustainability and working in partnership set the tone for the whole project.
**Regulatory issues**

The major regulatory issue for this project was gaining planning permission for the development on the site initially; no known problems or issues have been raised. This was agreed before the project was decided to be a demonstration project.

The use of foamix containing IBA was an issue of concern to the Environment Agency, because a ditch at the edge of the site leads to the River Itchen which is a candidate Special Area of Conservation under the Habitats Regulation and therefore has a high level of protection. The Environment Agency required further investigation to be carried out to identify the risks, if any, of using the IBA within the foamix. Viridis carried out a qualitative risk analysis to identify any risks that the use of IBA at the site might cause. It was found that the risk of the IBA causing harm to human health or the environment was very low. A programme of leaching tests and environmental monitoring was agreed by all parties to ensure that the use of IBA in foamix did not pose any risk to the environment.

The extensive testing of the IBA prior to use, preconditioning and the mixing into the foamix meant that the IBA was no longer classed as a controlled waste. The Bar End site was not therefore considered to require a Waste Management Licence or exemption to receive the Foamix.

**Conclusions**

This case study has shown how a number of different recycled and secondary aggregates can be used in a construction project with the same efficiency as if primary aggregates had been used. This case study has shown that construction projects can be influenced by the client and that specifying the use of recycled and secondary aggregates at the beginning of the project can have a beneficial effect. The importance of having all stakeholders in the project being involved in using the recycled aggregates has been illustrated by the success of this project. If one party is not committed to using the recycled and secondary aggregates it can influence the cost and quality of material that is supplied.

The specification for the foamix to be used on site had to be supplied by HCC and Foster Yeoman to ensure that it included the use of IBA from Chineham energy from waste plant. This was an unusual specification but has allowed the case study to show the use of a large quantity of IBA in foamix. The foamix was laid at the beginning of November with many interested parties visiting the site to see the operation. The project has already been a success in raising the awareness of using recycled aggregates in construction, which was demonstrated by the number of visitors who made the trip to the site to see the foamix being laid. It will hopefully encourage other contractors to use IBA in foamix with confidence.

**Details of Parties**

**Hampshire County Council**

**Hampshire County Council**

Environment Division - Waste Management

David Ward

The Castle, Winchester

Hampshire

SO23 8UD

Tel: 01962 847021