This digest is one of a series produced by the Aggregates Advisory Service to provide information on aggregates efficiency issues.

The aim of this service, funded by the Department of the Environment, Transport and the Regions, is to assist the Government to achieve its objective of reducing the construction industry's dependence on landwon primary aggregates and increasing the contribution from secondary and recycled materials.

Further information on aggregates efficiency issues, whether relating to primary, secondary or recycled materials, can be obtained from the Aggregates Advisory Service on Freephone no.0800 374 279, or visit the AAS website at http://www.planning.detr.gov.uk/aas/index.htm

THE USE OF COAL MINING WASTES AS AGGREGATE

This digest briefly reviews the use of coal mining wastes as secondary aggregate.

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A list of potential sources of colliery spoil is included in Digest 035 "Potential Sources of Secondary Aggregate in England and Wales"

Introduction

Coal mining wastes form the most abundant and widely available by-product in the UK potentially suited for use as aggregate. Although production rates are now declining in this country, millions of tonnes of colliery spoil are still stockpiled each year.

In 1990, the total stockpile was estimated at 3,600 million tonnes (*Arup, 1991*). This represents a vast potential secondary aggregate resource. However at present there is comparatively little use of colliery spoil. For example, the proportion of annual production re-used for road base construction in 1993 was 8% (*Scott Wilson Kirkpatrick Pavement Engineering, 1993, Unpublished*).

Colliery spoil, also known as minestone, has been used in the past as a secondary aggregate, but not to its full potential. The low grade, low value uses to which the material is generally suited, and an inability to bear significant transport costs, have impeded the more widespread application of minestone.

The National Coal Board placed an emphasis on encouraging the use of minestone as aggregate and formed the Minestone Executive specifically for this purpose. However, following privatisation, the Minestone Executive was disbanded and the

industry in its present form no longer promotes the use of minestone to the same extent.

Nevertheless there has been considerable local use of both minestone and burnt colliery spoil for various uses, including highway embankments, capping layers and sub-bases in road construction. Some examples are given in this digest.

What is Colliery Spoil?

Coal mining produces, as a by-product, colliery spoil which is a potential source of secondary aggregate material. Coal seams are typically found within layers of siltstones, mudstones and sandstones (and in Scotland, limestones). It is these underlying and overlying rocks that are inevitably brought to the surface when the coal seam is mined. When the coal is processed by washing prior to sale to the customer, colliery spoil (minestone) is produced in the form of coarse or fine discard.

Coarse discard forms the larger fraction of spoil and predominantly comprises sand and gravel size pieces (typically between 100mm and 1mm) of stone and shale. Residual coal in coarse discard from a modern washery should be less than 1% of the total volume.

The **fine discard** is, in essence, the solids settled or filtered from the "dirty water" from the washing process. These fine solids comprise the clay, silt and fine sand size pieces (typically less than 2mm) of stone and shale together with some very fine coal, too small to process economically. The residual coal in the fine discard may be as much as 30% or more of the total. Fine discard is usually pumped to settle in tailings lagoons or dewatered to produce a filter cake.

Combustion can occur in old spoil heaps (pre 1970) where inefficient washing left a high coal content and pre-Aberfan construction procedures gave rise to steep sided and poorly compacted heaps. Where spoil from old heaps still contains sufficient coal to cause problems, it is likely to be economic to rewash the heap and extract the coal. There is no record of combustion taking place in more modern spoil heaps.

Burnt and unburnt spoil are very different in their properties and are best considered separately. Burnt spoil is generally of higher strength than unburnt spoil and is consequently in higher demand. However, as old spoil heaps have become restored or naturally vegetated, burnt spoil is now rarely available for use as aggregate.

Uses of Colliery Spoil

Generally both burnt and unburnt colliery spoil are suitable materials for engineering fill in construction, but are unsuitable for use in concrete, unless processed to produce synthetic aggregate (*BRE, 1981*). Table 1 (at the end of this digest) summarises the current Highways Agency permitted uses of burnt and unburnt colliery spoil in highway works.

In addition to uses as general fill, most coarse discard can be compacted to a high degree of impermeability and the material has found frequent application in landfill cell and capping construction, river bank raising and even reservoir embankment construction.

Uses of Fine Discard

The normal problems in utilising fine discard are high moisture content and often, high coal content. Where comparatively dry fine discard is available (such as plate press filter cake) it can be suitable as a substitute clay. Where the residual coal content is sufficiently high it can be used as a secondary fuel. It is also technically quite feasible to manufacture lightweight aggregate from the material. A pilot plant was, in fact, constructed at Abernant Colliery in the early 1980s although this demonstration was curtailed by the closure of the colliery.

Specific Examples of the Use of Colliery Spoil

The following are examples of the use of colliery spoil in this country:

- Around 500,000 tonnes of minestone was used as selected fill for the construction of the Folkestone terminal of the Channel Tunnel;
- minestone was used to form highway embankments for the construction of the M62 motorway, Yorkshire and in the construction of many other major roads;
- in 1994 minestone was utilised in the construction of the A162 South Milford and Sherburn-in-Elmet bypass in North Yorkshire;
- minestone has been used by Wakefield MDC in the construction of the Welbeck Landfill Scheme;
- minestone was used to construct railway embankments at Crofton West Junction near Wakefield in West Yorkshire and at Gloucester Road Triangle near Croydon in Surrey;
- 340,000 Mm^3 minestone was used in the construction of the Selby-Wistow-Cawood Barrier Bank which protects over 2,000 properties from flood overspill of the River Ouse in Yorkshire;
- minestone from Kellingley Colliery, North Yorkshire, has been used at the rate of around one million tonnes per year to construct the embankments (in accordance with the Reservoirs Act) at National Power's Gale Common fly ash lagoon site;
- cement bound minestone was used for the construction of a long-stay car park at Gatwick Airport;
- minestone has been used in significant quantities as an impermeable general fill, by the Environment Agency, in raising river embankments and other flood defence works. In particular it has been used in a sea defence project between Deal and Sandwich in East Kent.

Table 1: Current Highways Agency permitted UK application of colliery spoil for highway works

	Use						
Material	Cement bound sub-base	Embankment and fill	Capping	Unbound sub-base	Cement-bound roadbase	Pavement quality concrete	Bitumen-bound layers
Burnt Colliery Spoil	✓	✓	✓	✓	×	×	×
Unburnt Colliery Spoil	✓	✓	×	×	×	×	×

✓ Permitted either specifically by name or if it complies with the requirements of the specification.

× Not permitted.

Useful References

Proceedings of a Symposium on the Reclamation, Treatment and Utilisation of Coal Mining Wastes. Published by National Coal Board Minestone Executive, 1984. [1]

Proceedings of the Second International Conference on the Reclamation, Treatment and Utilisation of Coal Mining Wastes. Published by British Coal Corporation, Minestone Executive, 1987. (ISBN 0 44 442876 3) [1, 2]

Composition and Engineering Properties of British Colliery Discards. Taylor. R.K. Published by the Mining Department of the National Coal Board, 1984. [1, 2]

Proceedings of the Third International Conference on the Reclamation, Treatment and Utilisation of Coal Mining Wastes. Published by British Coal Corporation, Minestone Executive, 1990 [1, 3]

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Occurrence and Utilisation of Mineral and Construction Wastes. Arup Economics & Planning for the Department of the Environment, 1991. (ISBN 0 11 752484 0) [4]

The Reclaimed and Recycled Construction Materials Handbook. CIRIA, due for publication May 1999 [5]

Use of Industrial By-Products in Road Construction: water quality effects. Baldwin. G et al. Published by CIRIA, 1997
(ISBN 0 86017 475 1) [5]

The Manufacture of Synthetic Aggregates from Colliery Spoil. IP 30/81. Building Research Establishment Information Paper. BRE, 1981 [6]

Sources of References

[1] all Minestone Executive reports are due to be held at the Public Records Office, Ruskin Avenue, Kew, Richmond, Surrey, TW9 4DU. Contact the Records Information Section, quoting “COAL 83”, to arrange an appointment to view reports (Tel: 0181 876 3444).

[2] may be viewed at the British Library by prior appointment only (Science & Technology Enquiries - Tel: 0171 412 7494).

[3] may be viewed at the Geological Society Library. However only Geological Society members may access the library easily (see our digest 025).

[4] may be obtained from the Stationery Office (Tel: 0171 873 0011)

[5] may be obtained from CIRIA publications hotline (Tel: 0171 799 3243)

[6] may be obtained from BRE (Tel: 01923 664000)